from the Author

Coventry Patmore

THE GREAT EXHIBITION,

AND

LONDON IN 1851.

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THE

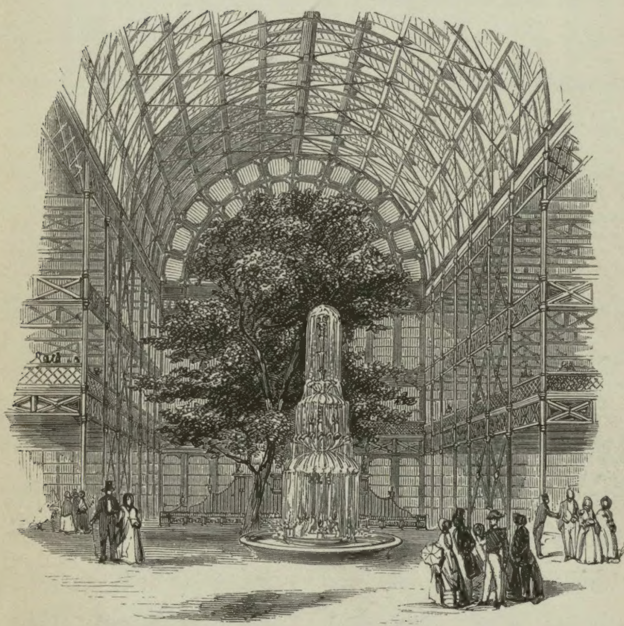
GREAT EXHIBITION,

AND

LONDON IN 1851,

REVIEWED BY

DR. LARDNER, &c.



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ADVERTISEMENT.

THE Reviews and Essays by Dr. Lardner, which form the principal part of the contents of the present volume, appeared in the "TIMES" during the progress of the Great Exhibition, and are now collected and republished with the consent of the proprietors of that Journal. They have been revised, and in some cases enlarged, by the Author, and illustrative cuts have been supplied, where they seemed necessary, for the better elucidation of the text.

The publishers, considering that the comments of eminent foreign publicists on the Exhibition would be regarded with interest, have annexed to this collection of Dr. Lardner's Essays translations of a discourse addressed by the Baron C. Dupin to his class, at the Conservatoire des Arts et Métiers; and a selection of Reviews published in the "Journal des Débats," by MM. Michel Chevalier, John Lemoinne, and Hector Berlioz.

London, April, 1852.

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PART I.

REVIEWS AND ESSAYS.

BY

DR. LARDNER.

I.

GIFTS OF SCIENCE TO INDUSTRY.

Each succeeding age and generation leaves behind it a peculiar character, which stands out in relief upon its annals, and is associated with it for ever in the memory of posterity. One is signalised for the invention of gunpowder, another for that of printing; one is rendered memorable by the revival of letters, another by the reformation of religion; one epoch is rendered illustrious by the discoveries of Newton, another by the conquests of Napoleon. If we are asked by what characteristic the present age will be marked in future records, we answer, by the miracles which have been wrought in the subjugation of the powers of the material world to the uses of the human race. In this respect no former epoch can approach to competition with it.

1. Steam.

Although the credit of the invention of the steam-engine must be conceded to the generation which has preceded us, its improvement and its most important applications are unquestionably due to our contemporaries. So little was the immortal Watt himself aware of the extent of the latent powers of that machine, that he declared, upon the occasion of his last visit to Cornwall, on ascertaining that a weight of

twenty-seven millions of pounds had been raised one foot high by the combustion of a bushel of coals under one of his boilers, that the *ne plus ultra* had been attained, and that the power of steam could no further go. Nevertheless the Patriarch of the Steam-engine lived to see forty millions of pounds raised the same height by the same quantity of fuel. Had he survived only a few years longer, he would have seen even this performance doubled. Still more recently it has, under favourable circumstances, been increased in a three-fold ratio.

But it is not in the mere elevation of mineral substances from the crust of the globe, nor in the drainage of the vast subterranean regions which have become the theatre of such extensive operations of industry and art, that steam has wrought its greatest miracles. By its agency coal is made to minister in an infinite variety of ways to the uses of society. By it coals are taught to spin, weave, dye, print, and dress silks, cottons, woollens, and other cloths; to make paper, and print books on it when made; to convert corn into flour; to press oil from the olive, and wine from the grape; to draw up metal from the bowels of the earth; to pound and smelt it, to melt and mould it; to forge it; to roll it, and to fashion it into every form that the most wayward caprice can desire. Do we traverse the deep? — they lend wings to the ship, and bid defiance to the natural opponents, the winds and the tides. Does the wind-bound ship desire to get out of port to start on her voyage? — steam throws its arms around her, and places her on the open sea. Do we traverse the land? — steam is harnessed to our chariot, and we outstrip the flight of the swiftest bird, and equal the fury of the tempest.*

* The preceding paragraphs, and several other parts of this article, formed part of an essay contributed by Dr. Lardner to the "Dublin

Many of these applications of this almost omnipotent agent were witnessed on a miniature scale in the Great Exhibition, and more especially in the department of "Machinery in Motion." On entering at one of the extreme western gates, the visitor found, in the enclosure outside that end of the Crystal Palace, a building appropriated to several large steam-boilers. These boilers were the heart from which flowed the vital fluid which animated the whole of that section of the Exhibition. A large steam main proceeded from this boiler-house, being buried in the ground in the same manner as the mains which supply gas and water to the metropolis. This main, being conducted into the building, was carried through it under the flooring along its northern wall, and continued to the limit of that part to which machinery was consigned. If, however, some precautionary expedients had not been adopted, the steam, in passing through so extended a pipe and to such a distance from its source, would have been condensed and reconverted into water by the cold to which it would have been exposed. This was prevented in the present case by clothing the main with a non-conducting coating—that is to say, with a coating which is impenetrable to heat. Various substances are used for this purpose in steam engineering, one of the most effectual being common sawdust. A steam boiler enclosed in a casing of common sawdust, loses scarcely any of its heat by radiation. It is customary, however, to clothe steam-pipes in a coating of patent felt, which is also a very good non-conductor. In fine, any fibrous texture, such as wool, cotton, or hemp, will answer the purpose.

But in order to render this steam effective as a mover of

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machinery, it must be worked by an engine; and since the Executive Committee supplied the steam, but did not supply the engines, the exhibitors arranged amongst themselves a system of mutual accommodation in this respect.

There were, of course, amongst the objects exhibited, a considerable number of steam-engines of different forms, and constructed on different principles, and it was desirable that these should be seen in operation. In some cases these exhibitors, having no other machinery in the Exhibition, found a convenience in applying their engines to move the machinery of other exhibitors, who, on the other hand, had no steam-engines in the Exhibition. In other cases, where the same exhibitor produced both machinery and steam-engines to move them, he had a surplus steam-power, which he willingly lent to his neighbour. By this arrangement, ample steam-power was everywhere found throughout that part of the building appropriated to machinery.

To explain the manner in which these several steam-engines were put in operation, let us imagine a branch steam-pipe attached to the great steam main, this branch pipe being conducted under the flooring to the place where the steam-engine is erected which it is intended to impel. The pipe is then conducted upwards by an elbow, and, in fine, attached to that part of the engine provided for the admission of steam. There was thus, as it were, a common boiler for all the steam-engines worked in the Exhibition, instead of having a separate boiler for each.

The manner in which the steam-engines imparted motion to the various machines seen at work being identical with that in which it is applied in the great factories, where similar operations are conducted on a much larger scale, it will be interesting here briefly to explain it.

The alternate motion of the piston from end to end of

the cylinder is first communicated to a crank with which the piston rod is connected; this crank consists of a sort of rectangular arm, like the winch by which a bucket is raised from a well, or by which a windlass is turned. The shaft upon which the crank is formed is thus kept in continual revolution.

This shaft is made to impart revolution to other shafts, either in its own direction or at right angles to it. If they are placed in its own direction, it is united to them by what is called a "coupling," which is a mechanical expedient by which two iron rods, being brought end to end in contact, may be so engaged with one another that one cannot revolve without the other revolving with it.

If it be desired to impart revolution to a shaft at right angles to the main shaft, the object is attained, as was seen in many parts of the Exhibition, by means of two bevelled wheels — that is to say, wheels whose teeth are cut in a direction obliquely to their axles.

But by far the most frequent and simple expedient by which one shaft can be made to impart revolution to another, whatever the direction of that other may be, is by means of an endless strap of leather, which is made to pass round the two shafts, or round the rims of wheels or drums attached to them. This endless band is stretched tight between the two shafts, so that it cannot slip over their surface, and its hold upon them is augmented by placing the rough surface of the leather next the face of the wheel.

The visitor saw with what beautiful simplicity, in every part of the Exhibition, the motion of each steam-engine was conveyed in every direction, upwards, downwards, and obliquely, from shaft to shaft, by these straps.

In the department of cotton machinery, instances of this on a considerable scale were seen; in some cases the shaft

which received revolution immediately from the engine passed under the flooring. It was connected by an endless strap with another which passed under the ceiling and over the machines, and this with various others parallel and at right angles to it.

It was observed with what facility and promptitude each machine was put in motion or stopped at the pleasure of the attendant, either by throwing the band on or off the driving wheel, or by coupling or uncoupling one shaft with another.

Most of the motions used in manufacturing machines being motions of continued rotation, they are imparted and maintained between the parts of the machines by expedients similar to those which we have just explained. In some cases, however, the motions required are alternate, as in the case of those self-acting spinning machines, in which the frame which carries the spindles moves alternately backwards and forwards, according as the thread is twisted and rolled up. Expedients are in that case contrived by which the motion at the proper moment is reversed, an example of which has already been mentioned, in the crank, whereby the alternate motion upwards and downwards, or backwards and forwards, of the piston of the steam-engine, is made to produce a motion of continued rotation in the crank. If the moving power were conveyed from the crank to the piston, instead of being conveyed from the piston to the crank, the same expedient would then convert a motion of continued rotation into an alternate motion backwards and forwards, or upwards and downwards.

Where a sudden and violent impulse is required to be imparted at intervals, a spiral spring is one of the expedients often adopted; some part of the machinery is made to act in compressing or extending this spring until the impulse is required to be given, at which moment the spring is disen-

gaged, and the impulse takes effect. Instances of this were seen in the variety of forms of the power-loom at work in the Exhibition. The shuttle, which in the common hand-loom is alternately thrown from right to left, and from left to right, between the hands of the weaver, is in this case jerked right and left by an arrangement urged by such springs.

When the monotonous regularity of the action of the hands and feet of a weaver at a hand-loom is considered, it is only wonderful that the idea of substituting mechanical power for such labour was not resorted to at an earlier period.

The beneficial influence of the Exhibition as a place of instruction would have been immeasurably augmented if, besides the machines themselves, sections and plans of them had been generally exhibited. The section conveys information which nothing but the dissection of the machines could do. The visitor was compelled to inquire, in some cases, as to the internal structure of the machines, and rarely found parties at hand able and willing to supply the necessary information. A plan and section, with short written or printed explanations, exhibited in juxtaposition with the machine, would in a great degree answer this purpose. Every one who has visited the Conservatoire des Arts et Métiers, in Paris, may have observed the advantages attending this expedient. There, near every piece of machinery exhibited, are posted or suspended plans, sections, and elevations explanatory of it.

Instances, however, of this occurred here and there even in the late Exhibition, one amongst others of which was seen in the section on marine engines, where Mr. Smith supplied a series of interesting and instructive drawings as well as models, showing the successive improvements through which the application of the screw-propeller has passed.

Models are still more instructive than drawings, or even than the machines themselves. The Exhibition afforded some striking and interesting examples of the advantages of such means of illustration. We would especially direct attention to the series of sectional models of steam-engines by Messrs. Watkin & Hill, of Charing Cross. By means of these admirable instruments of instruction all the internal parts of the engine may be seen, each part being animated with its proper motion. The engine is supposed to be cut through by a longitudinal vertical plane; one side of the model exhibits the real form of the engine, and the other side exhibits the section showing its internal mechanism. All the pistons, valves, slides, levers, and other moving parts move with exactly those motions which they have in the real machine; the motion which in the machine itself is produced by the action of the circulating fluids, such as water and steam, being produced in the model by mechanical contrivances.

One of these models represented a marine engine, another a locomotive, and the principal one, constructed in brass, and kept in motion by means of a small working model near it, a stationary condensing low-pressure engine, with all its appendages, as commonly used in the arts and manufactures.

If the observer examine carefully the movement of the parts, beginning at the great piston, he will observe that when that piston begins to descend, the slide which admits steam from the boiler to the top of the piston is open, as is also the passage which communicates between the bottom of the cylinder and the condenser, so that the steam urges the piston downwards against a vacuum. When it arrives at the bottom of the cylinder, he will observe the slide, governing the admission and escape of the steam, to shift its position,

the bottom of the cylinder being now put in communication with the boiler, and the top with the condenser; and thus the piston will be driven upwards by the pressure of the steam under it. If he then follow with his eye the passages leading to the condenser, he will see the air-pump working, and its valves opening and closing, by which the water and air are drawn from the condenser and thrown into the hot cistern. He will, in like manner, see the action of the hot and cold water pumps, the parallel motion, the governor, and, in a word, all the parts of the machine.

An intelligent and attentive observer, having some slight previous knowledge of the mechanical properties of steam, will, by the mere inspection of this model, obtain a more perfect knowledge of the steam-engine than he could acquire by days of study in books.

Sectional models were contrived, and first applied to the purposes of popular instruction, in Dublin, by Dr. Lardner, about the year 1825. Soon afterwards they were introduced in London, and their mechanical arrangements considerably improved, by the late Mr. Francis Watkins, with Dr. Lardner's direction and assistance. The first apparatus of this kind, on a large scale, was produced at a course of lectures delivered by Dr. Lardner, before the Royal Dublin Society, about the year 1826, for which a gold medal was voted by that body.

In the same section of the Great Exhibition was presented the model of a coal mine, bearing a close analogy to the sectional models just noticed.

No one, even amongst those who have themselves practically explored coal mines, can fail to have been struck with the clearness of perception which is obtained of such works from this model. Thus we have, first, those parts of the works which are above ground exhibited, such as the mouths

of the shafts and the engines which work them. There is, first, the shaft by which the coal is raised; next, that by which the mine is drained; and third, that by which it is ventilated. This latter process is usually accomplished by a furnace, which creates a draught of air up one of the shafts, which is necessarily followed by currents of air down the others.

In the lower part of the model is exhibited the state of the workings. The beds of unworked coal are represented by a black *stratum*, the workings being exhibited by cuttings through it, the railways being shown upon which the waggons move, in which the coal is brought to the bottom of the shaft, through which it is elevated by the power of a steam-engine erected at the top.

The partitions and other contrivances to regulate the ventilation of the works, were represented by brick-work in this interesting model. The timber supports used for sustaining the roof of the workings were also shown.

Coal-mines, or coal-fields, as they are sometimes called, differ from one another in the thickness of the bed of coal, and in the position in which it lies. In some the thickness does not exceed 18 inches, in others it amounts to many feet. In the coal-fields of Northumberland and Durham the average thickness is 12 feet, and, consequently, each acre contains 19,360 cubic yards of coal, each cubic yard weighing on the average 1 ton. The extent of the coal area in Northumberland and Durham is, in round numbers, 500,000 acres, and, consequently, its total contents amount to not less than 10,000,000,000 tons of coal, of which 1,500,000,000 only have been worked.

The present annual consumption is estimated at 10,000,000 tons, including the waste; and it consequently follows that, at this rate, it would take above *eight centuries* to exhaust this single field!

Not the least remarkable circumstance suggested by this model, is the prodigious depth at which this subterranean industry is carried on. In some cases the depth of the workings is 1800 perpendicular feet, or one-third of a mile; and the area of a single set of pits sometimes amounts to 1000 acres. The manner of working the beds may be collected, in some measure, from inspecting the model. The coal itself is first cut in narrow galleries — that is to say, a space is excavated 12 feet high and 4 or 5 feet wide — and such a gallery is continued, in a given direction, for a certain distance, as represented in the model. Others are then excavated parallel to it; afterwards a series of similar excavations are made at right angles to these; the result of which is, that square pillars of uncut coal remain, formed by the intersection of these rectangular galleries, and the plan of the bed resembles a chess-board, the black squares indicating the uncut pillars, and the white the open cuttings, only that the square pillars do not touch each other diagonally, as in the case of the chess-board. The use of these square pillars is to support the roof, which would otherwise fall in. After the bed has been worked in this way by parallel and rectangular galleries, the square pillars of coal are removed one by one, and the roof of the working is allowed to fall. This method of working a coal mine is called technically the method of "pillar and stall."

The apparatus for the ventilation of the mine, as indicated in the model, is extremely important, inasmuch as upon its efficiency the safety of this class of labourers mainly depends. The gas which, by artificial processes, is extricated from coal for the purposes of illumination, is found to issue spontaneously from the coal in the mine in greater or less quantity; so much so, that by holding a candle against the walls of the workings, jets of flame may be often produced.

When this gas is mixed in a certain proportion with the atmospheric air, which fills the workings—a mixture highly explosive — if a flame or spark come in contact with it, a destructive catastrophe ensues. Good ventilation prevents this evil. The current of air kept continually flowing through the workings, descending at the shaft No. 1. and No. 2. in the model, and rising at the shaft No. 3., is a safeguard against the evil; but, as this ventilation sometimes fails, a further security is afforded in the safety-lamp, which, as is well known, is a lantern surrounded with fine wire gauze instead of glass or horn. This wire gauze has the property of preventing the passage of flame through it.

According to the returns, it appears that in the Newcastle and Durham coal-field, represented by this model, there are about 200 pits or different collieries, employing 26,000 pairs of hands, the value of the coal at the port where it is shipped being about 11*s*. per ton.

This, however, is only one of the many astounding examples which the Exhibition presented to the foreign visitor, of the inexhaustible stock of this valuable mineral which lies embedded in this island, to say nothing of the Irish or Scotch specimens.

We had samples from South Wales, accompanied by models of the apparatus used for shipping the coals at Cardiff dock, where 400 tons per day can be shipped by steam-power from a coal-field presenting about 600,000 acres of coal area, consisting of the sorts best adapted for steam navigation, and thence called "steam-coal." We had also, supplied by the Butterly Company, specimens of the Derbyshire coal-field, consisting of seams of coal of great thickness. Mr. Atkinson sent specimens of coal from the Forest of Dean, where there is an area of 36,000 acres, the total thickness being about 37 feet. Specimens were sent from Barnsley, from a bed

10 feet thick, forming part of the South Yorkshire, Nottinghamshire, and Derbyshire coal-field, which includes 650,000 acres, of which there are 12 workable seams, of the total thickness of 20 feet.

It appears, in fine, that the total extent of coal area of the British islands amounts to 12,000 square miles, being about 1-10th of the entire area of the country; their annual production being 32,000,000 tons.

To form an estimate of the vast amount of mechanical power which is thus deposited under the soil of these islands, it is only necessary to be informed that a pint of water may be converted into steam by about two ounces of coal of average quality, and that in its evaporation it will develope a mechanical force equivalent to 35 tons weight raised one foot. After evaporation it will, by its expansion, produce a further amount of force equal to 70 tons raised one foot.

We take from a recent work the following illustrations of this source of mechanical power.*

A train of coaches weighing about 80 tons, and transporting 240 passengers with their luggage, has been taken from Liverpool to Birmingham, and back from Birmingham to Liverpool, the trip each way taking about four hours and a quarter, stoppages included. The distance between these places by the railway is 95 miles. This double journey of 190 miles was effected by the mechanical force produced in the combustion of 4 tons of coke, the value of which is about five pounds. To carry the same number of passengers daily between the same places by stage coaches on a common road, would require 20 coaches and an establishment of 3800 horses, with which the journey in each direction would be performed in about 12 hours, stoppages included.

* Dr. Lardner on the Steam Engine, 8th edition, p. 3. et seq.

The circumference of the earth measures 25,000 miles; if it were begirt with an iron railway, such a train as above described, carrying 240 passengers, would be drawn round it by the combustion of about 30 tons of coke, and the circuit would be accomplished in five weeks.

In the drainage of the Cornish mines, a bushel of coals usually raises 40,000 tons of water a foot high; but it has, on some occasions, raised 60,000 tons the same height. Let us take its labour at 50,000 tons raised one foot high. A horse worked in a fast stage coach pulls against an average resistance of about a quarter of a hundred weight. Against this he is able to work at the usual speed through about 8 miles daily; his work is, therefore, equivalent to 1000 tons raised one foot. A bushel of coals consequently, as used in Cornwall, performs as much labour as a day's work of 50 such horses.

The great pyramid of Egypt stands upon a base measuring 700 feet each way, and is 500 feet high, its weight being 12,760 millions of pounds. Herodotus states, that in constructing it 100,000 men were constantly employed for 20 years. The materials of this pyramid would be raised from the ground to their present position by the combustion of about 480 tons of coals.

The Menai Bridge consists of about 2000 tons of iron, and its height above the level of the water is 120 feet. Its mass might be lifted from the level of the water to its present position by the combustion of 4 bushels of coal.

The enormous consumption of coals produced by the application of the steam-engine in the arts and manufactures as well as to railways and navigation, has of late years excited the fears of many as to the possibility of the exhaustion of our coal mines. Such apprehensions are, however, altogether groundless. If the present consumption of coal be

estimated at 32,000,000 of tons annually, it is demonstrable that the coal-fields of this country would not be exhausted for many centuries.

But in speculations like these, the probable, if not certain, progress of improvement and discovery ought not to be overlooked; and we may safely pronounce that, long before such a period of time shall have rolled away, other and more powerful mechanical agents will supersede the use of coal. Philosophy already directs her finger at sources of inexhaustible power in the phenomena of electricity and magnetism. The alternate decomposition and recomposition of water by electric action, has too close an analogy to the alternate processes of vaporisation and condensation not to occur at once to every mind; the development of the gases from solid matter by the operation of the chemical affinities, and their subsequent condensation into the liquid form, has already been essayed as a source of power. In a word, the general state of physical science at this moment, the vigour, activity, and sagacity with which researches in it are prosecuted in every civilised country, the increasing consideration in which scientific men are held, and the personal honours and rewards which begin to be conferred upon them, all justify the expectation that we are on the eve of physical discoveries still greater than any which have yet appeared; that the steam-engine itself, with its gigantic powers, will dwindle into insignificance in comparison with the energies of nature which are still to be revealed, and that the day will come when that machine, which is now extending the blessings of civilisation to the most remote skirts of the globe, will cease to have existence except in the page of history.

2. Artificial Light.

Marvellous as the uses are to which science has rendered Heat subservient, those which have been obtained from light by the combination of the researches of the chemical and the genius of the mechanical philosopher, have not been less striking. Ready made flame is fabricated in vast establishments, on an enormous scale, erected in the suburbs of cities and towns, and transmitted in subterranean pipes through the streets and into the buildings and dwelling-houses, where, after the close of the natural day, an artificial day is thus created, guiding us in the pursuit of business or of pleasure, and adding to the sum of life by rendering hours pleasant and useful, which must, in the absence of artificial light, have been lost in torpor or in sleep. It is supplied, according to individual wants, in measured quantity, and at every door an automaton is stationed, by which a faithful register is kept of the quantity delivered from hour to hour.

Flame, which is, in most cases, the source of artificial light, is gas rendered white hot. The gas, such as is prepared for the purposes of illumination, contains, in the latent state, the heat which, in the process of combustion, renders it incandescent. The moment combustion commences, the gas entering into combination with the oxygen, which is one of the constituents of the atmosphere, the heat, which was till then latent, becomes sensible, and affecting the gas itself while combining with the oxygen, renders it *white hot.*

Whatever be the source of the flame used for artificial light, whether it proceed from the gas produced in the great works above mentioned, or from oil, tallow, wax, or other unctuous or spirituous substances, it derives its illuminating properties from the presence of two substances, called hydrogen and carbon, both highly combustible. Hydrogen

combining with oxygen forms water, developes an intense heat, but produces only a faint bluish light. Carbon combining with oxygen, forms a gas called carbonic acid, and gives whiteness to the flame when united with hydrogen. This whiteness and splendour is generally the more intense the greater the proportion of carbon is which enters the combustible.

The gas used for illumination, and which is extracted from pit-coal by baking it in close iron vessels called retorts, is called carburetted hydrogen, and is, as the name imports, composed of hydrogen gas and carbon, chemically combined. Being extracted from the coal, purified from all foreign matter at the gas-works, and collected in capacious vessels called gasometers, it is kept under a regulated pressure, which is sufficient, and not more than sufficient, to propel it through the pipes by which it is conveyed to the places of consumption, and to cause it to issue from the burners with the necessary force.

So immediate is the transmission of the effect of pressure from the gas-works to the most distant burners, that no appreciable time elapses between a change of pressure and the consequent flicker of a gas-light six miles distant.

Whatever be the combustible used in lamps, and other apparatus adapted to produce flame for artificial illumination, the principle on which the evolution of heat and light depends is the same. The combustible, be it oil, tallow, wax, or spirit, always contains hydrogen and carbon in some determinate proportion. On the application of heat, a small portion is first converted into vapour, and then ignited. The combustion having once commenced, the heat, before latent in the hydrogen and carbon, becomes sensible, gives splendour to the flame, and is effective in vaporising the combustible, and sustaining the combustion.

The number of expedients for the production of artificial light, from the common candle, through all the varieties of lamps, to the more scientific expedients, the oxy-hydrogen and electric lights, which appeared in the Exhibition, is infinitely various.

Lamps in which artificial light is produced by means of a liquid combustible may be reduced to two classes, one in which the liquid is drawn to the wick by capillary attraction, and the other in which it is propelled there by mechanical agency. It is evident that in the former the distance of the reservoir from the wick must be much more limited than in the latter. Hence we find that the mechanical lamps known as Carcels and Moderators are more elegant in their forms than those which, depending on capillary action, have oil vessels of greater or less magnitude immediately under the flame, and which therefore cannot be sinumbral. Of the capillary lamps, in which oil or fatty liquids are burnt, the most simple is that called the solar lamp; but by far the most brilliant in its illuminating power, and the most economical in its use, is one of recent introduction called the camphine lamp. The liquid burnt in this lamp is spirits of turpentine, which has recently been called, in reference to these lamps (for no reason that we can conceive), camphine. A well constructed camphine lamp will have an illuminating power equal to that of a dozen wax candles, and will cost, when burning, at the rate of a halfpenny an hour, being just the cost of burning a single wax candle.

Of the mechanical lamps exhibited, especially in the foreign department, the most efficient and the most elegant in its form is the Carcel lamp. In this description of lamp a small pump, placed in the reservoir of oil, is kept continually working by means of a mainspring, wheelwork, and regulator. The effect is, that the oil is continually

pumped up to the wick, where it overflows and returns to the reservoir. In lamps of this form, therefore, the oil reservoir may be placed as far below the wick as is proportionate to the power of the pump, and the lamp consequently may consist of a narrow pillar, having the burner at its summit and the oil reservoir at its base. These lamps have been for many years in general use in Paris and other parts of the Continent, and, when well constructed, will not require cleaning or repairing more frequently than a watch.

The mechanical lamps called Moderators are cheaper, but less efficient, than the Carcel. In these a leathern piston is urged against the oil by the force of a spiral spring, and there is a regulator of imperfect and unsatisfactory action by which the supply of oil to the wick is limited. These lamps, as compared with the Carcel lamps, are subject also to the objection that they require more frequently winding up. A well-constructed Carcel lamp will burn without requiring to be wound up for twelve or fourteen hours, whereas it is difficult to find a Moderator which will not go out at the end of three or four hours.

The more scientific expedients for the production of artificial light depend in general on imparting such an intense heat to a solid body as to render it vividly incandescent, without, however, liquefying it or causing its combustion. The expedient of this class which is best known is the oxy-hydrogen light, by which the microscope and lanterns for dissolving views exhibited in the Polytechnic Institution are illuminated, and which were found in various improved forms in the Exhibition. We may refer here more particularly to an apparatus improved by the Rev. Mr. Beechy, and exhibited by Messrs. Abraham & Co. of Liverpool.

The principle of the oxy-hydrogen light is easily explained. If a jet of pure hydrogen gas be ignited, it will produce a

pale bluish flame, having a considerable calorific power. In this case the combustion is maintained by the combination of the hydrogen gas with the oxygen of the air; but much more active and infinitely greater calorific effects will be produced if pure oxygen be directly supplied to the hydrogen at the moment it is ignited. In the oxy-hydrogen lamp this is effected in the following manner: two reservoirs of gas, one of oxygen, the other of hydrogen, are provided, which communicate with a common burner. Being submitted to equal pressures, they will issue from the burner in the proportion necessary to form water, and which will also produce the most vivid combustion, and the most intense heating power. If this flame be directed upon any of the common metals it will burn them as though they were paper, and it will immediately fuse platinum. If it be directed upon a piece of lime, which it cannot either burn or fuse, it will render it so intensely hot that it will become vividly luminous, and, if the jet be sufficiently powerful, the light which the lime will thus emit will be far more intense than any other artificial light yet produced, with the exception of one which we shall presently notice. As the lime would be gradually destroyed by the mechanical action of the gas upon it, it is usual in oxy-hydrogen lamps to form it into a small cylinder placed upon a spindle, which is kept in slow revolution, under the action of the flame, by clockwork.

It is remarkable that the flame which possesses this strong heating power, and which renders the lime so intensely luminous, has itself but a feeble illuminating power.

Hitherto the production of this artificial light has not been sufficiently improved to render it available for the common purposes of illumination; it has, however, been used as a signal-light with some success in great trigonometrical sur-

veys, where it is said to have been visible through a thick cloud surrounding the hill on which it was placed.

In its application to the microscope, the rays issuing from the lime are received upon a large converging lens of glass, by means of which they are collected to a focus upon the object to be illuminated.

An artificial light, somewhat analogous to this, has recently been brought into use to some extent in Paris. Pure hydrogen gas, produced by a certain process from coal, is proposed for street and domestic illumination, instead of the carburetted hydrogen commonly used. A thin spiral wire of platinum is suspended over the burner of the lamp, and the flame of the pure hydrogen, which itself gives but a feeble light, playing upon this wire, renders it incandescent and so strongly luminous as to diffuse more light than the fan burner of a common gas lamp. Lamps of this construction may be seen in Paris in the neighbourhood of the establishment where this system has been established, near the Barrière de l'Etoile. Hitherto, however, the system has not obtained general acceptation.

The apparatus for the production of the electric light, which is still more intense than the oxy-hydrogen light, and produced under conditions which present greater probability of being ultimately adapted to economical uses, are exhibited in different forms by Messrs. Deleuil & Co., and by Messrs. Duboscq, the successor of the celebrated Soleil, of Paris. Mr. Allman has also in this country obtained a patent for another apparatus of a similar kind.

This artificial light is produced by connecting two pencils of charcoal with the poles of a powerful galvanic battery. If the points of the charcoal thus connected be brought into contact, the galvanic circle being completed, and the charcoal being to some extent a conductor, the current will pass from

the one point to the other, and, in so passing, heat is developed in such enormous quantities in the charcoal as to render it incandescent. The light which proceeds from it is of the most intense splendour; so much so, that it cannot be looked at without protecting the eye by coloured glasses. The colour and quality of the light is similar to that of the sun, as is proved by the fact that when it is analysed by the prism it gives the same component parts. To produce this light in its full splendour it is necessary to have a battery of at least fifty pairs. The battery used in Paris, where the light has been lately exhibited, is that of Bunsen, consisting of cylinders of charcoal immersed in pure nitric acid, and cylinders of zinc immersed in dilute sulphuric acid. These cylinders are about 12 inches in height, that of the zinc 4 inches in diameter, and of the charcoal 2 inches. The vessel containing the charcoal is separated from that of the zinc by porous porcelain. Messrs. Deleuil & Co. have, we believe, obtained a patent in France for the fabrication of the charcoal cylinders, which are composed of charcoal obtained from coke, and hardened and condensed by artificial means.

The lamp of M. Deleuil consists of two small pencils of charcoal, hardened and prepared from coke, which are brought into and kept in contact by an apparatus governed by an electro-magnet. When, by the consumption of the pencils, the current has a tendency to be suspended, the action of the electro-magnet taking effect upon certain parts of the apparatus, brings the charcoal pencils again into the proper position for the production of the light.

The electric lamp of M. Duboscq is more complicated, but claims to produce a more steady and uniform light. In this apparatus the charcoal points are kept in contact by a system of clockwork, which is, like the former, governed by an electro-magnet.

We have witnessed the effect of both of these lamps, and find the light produced by the one and the other sufficiently steady for all the purposes of the microscope, to which they have both been applied.

Apparatus have also been constructed by M. Duboscq for the purpose of illustrating, for academical classes, all the optical phenomena of the spectrum, of double refraction, and polarization. Nothing can be more satisfactory than the experiments thus made. The spectral lines of Frauenhofer are shown with perfect distinctness by it, also the colours of the prismatic spectrum, and all the usual experiments upon their combination and separation. The rings and crosses produced by the interference of polarized light are also beautifully shown. M. Duboscq has adopted this light also for the exhibition of dissolving views, a single light being sufficient for the two lanterns. The light is, in this case, placed between the lanterns and reflected by mirrors placed at angles of 45 degrees with the axes of the lenses. We have witnessed the effect of this, and can vouch that the results are quite satisfactory.

It is only just here to state that the merit of the first application of the electric light to the microscope and to the general illustration of optical phenomena, is due to M. Leon Foucault, who has lately obtained a world-wide celebrity by his beautiful experimental test of the rotation of the earth.

The electric lamp may be thus considered to be an important accessory to the lecture-room, and likely soon to become, when further improved, an object of great utility in artificial illumination. It is known that Mr. Allman is now engaged in a series of experiments, with a view to the improvement of its economical application.

3. Photography.

It resulted from scientific researches on the properties of solar light, that certain metallic preparations were affected in a peculiar manner by being exposed to various degrees of light and shade. This hint was not lost. An individual, whose name has since become memorable, M. Daguerre, thought that as engraving consisted of nothing but the representation of objects by means of incisions on a metallic plate, corresponding to the lights and shades of the object represented — and as these same lights and shades were shown by the discoveries of science to produce on metals specific effects, in the exact proportion of their intensities — there could be no reason why the objects to be represented should not be made to *engrave themselves* on plates properly prepared!! Hence arose the beautiful art now become so universally useful, and called after its inventor — Daguerreotype.

The object of which it is desired to produce a representation, is placed before an optical instrument, with which every one is familiar as the camera-obscura. An exact representation of it, on a scale reduced in any required proportion, is thus formed upon a plate of ground glass, so that it may be viewed by the operator, who can thus adjust the instrument in such a manner as to obtain an exact picture of it. If it be desired to make a portrait, the effect of the posture of the sitter can thus be seen, and the most favourable position ascertained before the process is commenced.

When these arrangements have been made, the plate of ground glass, on which the picture was previously formed, is withdrawn, and the metallic plate, on which the picture is to be engraved, is substituted for it. This latter being placed in the groove from which the plate of ground glass has been

withdrawn, the picture will be formed upon it with the same degree of precision, and in exactly the same position in which it was previously seen on the plate of ground glass.

When the light is favourable, four or five seconds are sufficient to produce the desired effect by the processes which have been hitherto generally adopted. According as it is less intense, the necessary time may be greater, but never should exceed a minute. In general, the shorter the time in which a picture is made, the more perfect the picture will be, especially if it be a portrait, because the defects of the representation most commonly arise from the object represented, or some part of it, having shifted its position during the process. In that case, the picture presents the object as though it were seen through a mist. The best portraits we have ever seen produced by this art have been completed in four seconds!

It might be supposed, from what we have here said, that it would be almost impossible, in any case, to obtain a perfect representation of the eyes in a portrait, because of the difficulty of abstaining from winking. It happens, however, that winking being a change of position which is only continued for an inappreciable instant of time, the eye resuming its position immediately, is almost the only movement incidental to a sitter which does not affect the precision of the portrait; unless, indeed, the action of winking were to be continued in rapid succession, which rarely occurs.

Some recent experiments, however, render it probable that the exposure of the prepared surface to the optical image for an inappreciably short interval, an instant, in fine, will be rendered sufficient to produce a perfect photographic picture. All that is necessary to accomplish this, is to obtain a sufficiently strong illumination of the object to be represented, and to impart sufficient sensitiveness to the

surface upon which the optical picture is required to produce the photographic effect. To what extent these conditions are likely to be fulfilled, may be inferred from an experiment reported to have been lately exhibited at one of the meetings of the Royal Society. A printed paper was fastened upon the face of a wheel, which was put in revolution with such rapidity that the characters on the paper ceased to be visible. The camera, with the prepared photographic surface, being placed opposite the wheel and properly adjusted, the room was darkened. The room and wheel were then illuminated, for *an instant*, by a strong spark taken from the conductor of a powerful electric machine. This instantaneous appearance of the wheel before the camera was sufficient to produce a perfect picture.

One of the defects of Daguerreotype, as applied to portraiture, arises from the impossibility of bringing the entire person of the sitter at once into focus. To render this possible, it would be necessary that every part of the person should be at precisely the same distance from the lens of the camera, a condition which obviously cannot be fulfilled. It happens, consequently, that those parts which are nearest to the lens, will be represented on a scale a little greater than those which are most distant; and if the instrument be adjusted so as to bring the nearer into very exact focus, the more distant will be proportionally out of focus.

These defects cannot be removed, but may be so much mitigated as to be imperceptible. By using larger lenses, the camera can be placed at a considerable distance from the sitter, without inconveniently diminishing the size of the picture. By this expedient, the difference between the distances of different points of the sitter from the lens, will bear so small a proportion to the whole distance, that the amount of distortion arising from the cause just mentioned, may be

rendered almost imperceptible. Large lenses, however, when good in quality, are expensive; and it is only the more extensively employed practitioners in this business that can afford to use them.

The discovery of this beautiful application of the chemical properties of light is of very recent date. Efforts to fix illuminated images by means of the chemical agency of light, were made by Wedgwood and Davy as early as 1802, but without success, no preparation being discovered capable of rendering a surface sufficiently sensitive to be affected by the subdued light of a camera. Sir H. Davy produced a faint impression of the illuminated image produced in a solar microscope, but being unacquainted with any method of suspending the further action of light on the picture, no permanently perfect effect resulted, and the subject was laid aside. In the fourteen years which elapsed between 1814 and 1828, the labours of M. Daguerre and M. Niepce were directed to the solution of the problem.

In 1827, a memoir was presented by the latter to the Royal Society, accompanied by several specimens of *Heliographs* * (so he called them). These, which are still extant, show that M. Niepce was acquainted with a method of forming pictures by which the lights and shadows are represented as in nature, and when so formed of rendering the picture proof against the further effects of light. M. Niepce, however, having concealed his processes, describing only the results, the Society could not, according to its rules, admit his memoir into the Transactions.

The surfaces upon which he produced his pictures were those of glass, copper plated with silver, and well polished tin.

* *Sun-drawn* pictures.

Those upon which M. Daguerre produced his first pictures, were paper impregnated with nitrate of silver.

MM. Daguerre and Niepce having combined to perfect the art, the results of their labours were promulged to the world in 1839, when the French Chambers adopted a law, which received the royal assent, conferring a life pension of 240*l.* on M. Daguerre, and one of 160*l.* on the son of M. Niepce, with reversions of half these amounts respectively to their widows, in consideration of their disclosing the secret of their process and renouncing their right to any patented monopoly. The grant was declared to be made for the glory of having endowed science and art with one of the most astonishing discoveries which ever honoured France.

About six months before the disclosure of the processes of Daguerre and Niepce, Mr. Fox Talbot read before the Royal Society a memoir, in which he explained his photographic researches, and showed the manner in which he produced upon paper, rendered sensitive by chemical preparations, photographic pictures.

The instrument first used by Mr. Fox Talbot for producing the optical picture upon the prepared paper, was the solar microscope, and not the camera-obscura. The sensitiveness which he imparted to the paper, and the success of his first results, may be inferred from the following extract from his memoir.

"It is so natural to associate the idea of labour with great complexity and elaborate detail of execution, that one is more struck at seeing the thousand florets of an *agrostis* depicted with all its capillary branchlets (and so accurately, that none of all this multitude shall want its little bivalve calyx, requiring to be examined through a lens), than one is by the picture of the large and simple leaf of an oak or a chesnut. But, in truth, the difficulty is in both cases the

same. The one of these takes no more time to execute than the other; for the object which would take the most skilful artist days and weeks of labour to trace or to copy, is effected by the boundless powers of natural chemistry in the space of a few seconds. * * * * To give some more definite idea of the rapidity of the process, I will state that, after various trials, the nearest valuation which I could make of the time necessary for obtaining the picture of an object, so as to have pretty distinct outlines, when I employed the full sunshine, was *half a second!*"

The vast number of beautiful specimens of sun-drawn pictures, on various sorts of surfaces, which were presented in the Exhibition, demonstrate how great and how rapid has been the progress of the art from the date of its invention. These results are variously denominated either from the name of their inventor or discoverer, as Daguerreotype and Talbotype, or from the chemical principle by which the surface destined to receive the picture is rendered sensitive to light, as cyanotype, chrysotype, chromotype.

The surfaces on which these sun-painted pictures are delineated, are, besides the plated copper adapted to ordinary Daguerreotype, paper, silk, and other fabrics; glass, porcelain, marble, steel, wood, and ivory.

In the Talbotype process, the surface, first coated with a pure iodide of silver, is rendered sensitive to the impression of lights and shadows, by a wash composed of a mixture of gallic acid and nitrate of silver. After exposure to the optical picture in the camera, an invisible picture is produced upon it, which is brought out by a second application of gallic acid.

The processes for producing cyanotype and chrysotype pictures, which are very various, are described at length in the Memoir of Sir J. Herschel on this subject. The cyano-

types depend on the power of the solar rays to convert a per-salt of iron into a proto-salt. After this change, the picture is washed with a compound of cyanogen, and becomes visible, the lights and shades being exhibited in the tint of Prussian blue. It is this part of the process which has given it the name, cyanotype.

In the case of chrysotype pictures, the preliminary treatment with the salt of iron is the same as in cyanotype; but a solution of gold is substituted for the compound of cyanogen, and the lights and shades of the picture, instead of being exhibited in Prussian blue, appear in the colour of the oxyde of gold. "When washed with the gold solution, the picture," says Sir J. Herschel, "instantly appears, not indeed at once of its full intensity, but darkening with great rapidity up to a certain point, at which nothing can surpass the sharpness and perfection of detail."

Pictures produced by the photographic processes are of two kinds: 1. Positive pictures, in which the lights and shadows correspond with those of the object represented; and 2. Negative pictures, in which the lights and shadows are reversed, the lights being represented by shadows, and the shadows by lights.

In the Talbotype or Calotype process, as it is sometimes called, the picture produced in the camera is usually negative. This picture being laid upon another paper coated with chloride of silver, and then exposed in sunshine, a positive picture, corresponding exactly with the negative one, is obtained. Mr. Samuel Butler, of Peterborough, obtained a council medal for a beautiful series of photographic pictures obtained by this process, called photographic printing. The pictures represent scenes in and near Peterborough, and Bury St. Edmund's.

The application of glass to photography has lately occu-

pied many experimentalists, and more especially Sir J. Herschel. The surface of the glass is *albumenised* by a coating of a solution of the iodide of potassium and the white of egg. This having been carefully dried, is washed with a solution of the gallo nitrate of silver, previously to being placed in the camera, by which it is rendered highly sensitive to light. Messrs. Ross and Thomson obtained a council medal for this improvement.

In many of the processes curious and beautiful changes are exhibited, the picture first produced being negative, and being *washed into* a positive picture. Thus, in the cyanotype process, the picture produced directly in the camera, by the operation of light, is negative, when sufficiently strong to be visible. When a thin wash of the solution of cyanogen is applied to it, the negative picture wholly disappears, the surface for a certain interval is vacant ; but by very slow degrees a positive picture, tinted in violet blue, upon a greenish yellow ground, takes its place, exhibiting the highest degree of sharpness of delineation, and a singular beauty and delicacy of tint.

Among the numerous uses to which this invention is applicable, examples were presented in the Exhibition of its power of delineating, with incontestable accuracy, the lineaments of celestial objects. Thus, photographic images of the sun and moon were exhibited ; also images of the solar spectrum, produced by a prism on surfaces prepared with iodide and bromo-iodide of silver.

The application of this process to produce permanent pictures of astronomical phenomena, so transitory in their appearance as to render any direct and accurate observation of them difficult or impracticable, such, for example, as certain appearances in solar eclipses, would be highly advantageous.

One of the most interesting objects presented, were Daguerreotypes of the clouds taken in boisterous weather, forming an instructive study, not only for the meteorologist, but the artist.

In photography, the American department was peculiarly rich; and it is but just to state, that many important improvements in the details of photographic processes, have been supplied by the skill and unwearied experimental research of our transatlantic cousins.

Mr. J. Whipple, of Boston, exhibited several remarkable Daguerreotypes, among which, one of the moon was especially remarkable. In this picture, taken by means of a large equatoreal, the lineaments of the lunar surface were very beautifully displayed. Mr. Bond, another American, exhibited, at one of the late meetings of the British Association, several Daguerreotypes of the moon, taken with the 23 feet equatoreal of the Cambridge University (United States) Observatory. Mr. Bond, however, stated, that although very steady, the instrument was not sufficiently so to give pictures with very high powers. Sir David Brewster stated, that if Daguerreotypes of similar magnitude had been taken on transparent sheets of gelatine paper, and so placed before a telescope as to subtend an angle of half a degree, they would assume the same appearance as the moon itself.*

Mr. J. H. Whitehurst, of Baltimore, exhibited some beautiful Daguerreotypes of the Falls of Niagara. The cloud of white spray which rises from the base of the fall, and the white sheets of foam on the water, contrasted with the trees and the surrounding scenery, produced a remarkable effect. It is generally imagined, that the motion of the water and of

* Official Catalogue, vol. iii. p. 1463.

the spray would render a distinct picture by Daguerreotype impracticable. In practice, however, this is not found to be attended with any injurious effect upon the result.*

One of the most striking, and, we may add, unlooked-for uses of the photographic art, is its application to the constructing of a self-registering apparatus for meteorological phenomena, an invention of Mr. Charles Brooke, of London, who has been most deservedly rewarded for it by the council medal.

It is known to all who take an interest in physical science, that the most important laws which prevail in atmospherical and terrestrial phenomena, are intimately related to the horary and diurnal variations of the barometer, thermometer, hygrometer, the declination needle, dipping needle, and in fine to the changes which continually affect all those delicate and sensitive instruments, which the skill and genius of scientific men have contrived, to indicate the succession of meteorological phenomena manifested around us. To obtain a perfect record of the indications of these several instruments, it would be necessary that an observer should be stationed at each of them continually night and day, in all seasons, to note down their changes, which are continual, and sometimes sudden, such as cannot be foreseen or anticipated. These changes, moreover, are in some cases so rapid and fleeting, as to be incapable of exact estimation or measurement, even by the most vigilant and practised observers. The object of the invention of Mr. Brooke, is to make the phenomena keep a constant and unerring *record of themselves*, in photographic writing.

Without attempting a detailed description of this very beautiful automatic apparatus, which, besides, could not be

* Official Catalogue, vol. iii. p. 1460.

made intelligible without several complicated drawings, the general principle by which its indications are made may be briefly and clearly explained.

A pencil of light, brought to a focus by spherical or cylindrical lenses or reflectors, is so governed, that its point or focus has a motion identical with, or bearing a known proportion to, the motion of part of the instrument which affords the indications to be registered. Thus, if the instrument be a magnetic needle, the axis of the lens or speculum is made to coincide with, or make a known and constant angle with, the needle, and, therefore, to participate in its movements. The focus of the pencil refracted or reflected, receives a corresponding motion. If it be a column of mercury, as in the case of a barometer or thermometer, the direction of the pencil of light is varied, either by means of a float, which rises and falls with the mercurial column, or by transmitting the light through the tube, so as to produce the shadow of the column, in which case the movement of the shadow will be registered.

The focus of the luminous pencil is made to fall upon a sheet of photographic paper; and if both it and the paper were stationary, a spot would be produced upon the paper at the place where the focus falls upon it. If, owing to the variation of the instrument whose indications are to be recorded, the focus of the luminous pencil moves, a line will be traced on the photographic paper, the length of which will bear a known relation to the variation of the instrument. Thus, if it be a magnetic needle, a variation of one degree east or west in its direction, may impart a motion of an inch right or left to the focus of the luminous pencil, and a line of corresponding length would be traced upon the photographic paper. But by this means nothing would be recorded, except the extreme variation of the needle, in a given

time. An observer would still be necessary, and nothing would be accomplished more than is already attained by the self-registering thermometers, which show the maximum and minimum temperatures indicated during a given interval.

The apparatus is, however, rendered perfect, by rolling the photographic paper on a cylinder, which is moved by clock-work, so that a known length of the paper moves under the focus of the luminous pencil in a given time. When the focus of the pencil is stationary, a straight line is traced on the paper in a direction at right angles to the motion of the paper, and therefore parallel to the axis of the cylinder; but when the focus moves, as usually happens, to the right and left alternately, an undulating curve is traced upon the paper, the distances of the points of which from a known base line (also traced upon the paper), show not only the particular minute and second at which each change took place, but the actual state of the instrument at that moment.

In this way the heights of the barometer and thermometer, the variations of the declination and dipping needles, the directions of the wind-vane, and, in fine, the indications of all other meteorological instruments, are faithfully and continually registered, from minute to minute, and from hour to hour, by night and by day, in summer and in winter, and in all positions which it may be necessary to give to the instrument of observation, whether on the summits of lofty towers or mountains, in the caves of the observatory, or in the workings of mines hundreds or thousands of feet above or below the common level of the surface, in the absence and independent of any other care or interference on the part of an observer, save that which is necessary from time to time to supply this ever-wakeful and ever-active scribe with a fresh supply of paper.

An apparatus constructed in this manner, has been adopted

for registering the meteorological indications of the instruments at the Royal Observatory at Greenwich, with the greatest advantage. Since its introduction, the staff of observers has been reduced in number, and the fatiguing process of nocturnal observation has been altogether superseded.

Specimens of the registers obtained by this apparatus were exhibited in the Crystal Palace, including a lithographic facsimile of one day's work of all the instruments.

Although it be not connected with photography, it may not be out of place here to notice a beautiful apparatus exhibited by Mr. George Dollond, of St. Paul's Churchyard, which, like that just noticed, forms a self-acting register of all the most important meteorological phenomena, and which has likewise been rewarded by a council medal.

This apparatus differs from the former in the mode of recording the indications of the several instruments, the same method being selected as that which was adopted by Dr. Lardner in a self-registering apparatus for recording the state of the machinery of steam-vessels, a report of which was presented to the British Association some years ago. Pencils and styles are connected, by means of floats and various well-known mechanical connections, with the moving parts of the several indicators, and the paper, being moved under them by clockwork, marks are produced by pressure or puncture.

This apparatus of Mr. Dollond records the changes in — 1. the barometer; 2. the thermometer; 3. the hygrometer; 4. the electrometer; 5. the pluviometer; 6. the evaporator; 7. the force of the wind; 8. the direction of the wind.

It is obvious that the same indications could be registered on the principle of Mr. Brooke, with many more advantages. Our limits, however, forbid us to enlarge on this subject.

Physical researches relating to the properties of light, suggested the probability, if not the certainty, that rays enter

into the composition of that principle which are not luminous, or at least which do not affect, in a sensible manner, the most sensitive eyes. Thus, in the dark space below the red extremity of the prismatic spectrum, the thermometer is more strongly affected than in its most vividly luminous part, and the chemical effects manifested by the discoloration of certain salts are produced in a more decided manner in the dark space above the violet extremity, than within the illuminated space. Certain photographic effects confirm the inference deduced from these phenomena, that the chemical rays which enter into the composition of solar light, are not luminous, or at least not sensibly so. Thus, a picture covered with a plate of yellow glass, will be seen through the glass distinctly, the glass absorbing only a small proportion of the luminous rays; but the same picture, covered by a plate of deep blue glass, will be invisible, the blue glass absorbing nearly all luminous rays. Now, if the rays issuing in both these cases through the glasses, yellow and blue, be made to form a picture on a sensitive photographic surface, those transmitted through the yellow glass, and which are strongly luminous, will not produce any picture, while those transmitted through the blue glass, which are not visible, will produce a picture as strongly developed, and as distinct in its most minute details, as if the original had no glass whatever placed upon it. It follows, therefore, that the blue glass, which is nearly opaque, and which intercepts nearly all the visible rays, intercepts none of those rays by which the photographic effects are produced.

We are therefore compelled, strange as the result may appear, to infer that light is a compound principle, in which there are constituent rays partaking of the other optical properties, being refrangible and reflexible, but which are not luminous, or, to speak more strictly, not visible; and,

further, that it is precisely this component, this *dark light,* which produces all the phenomena of photography.

We shall call these dark rays *photogenic rays.*

Now it follows, also, as a consequence of numerous experimental researches in this novel and interesting field of optical inquiry, that these photogenic rays have not the same refrangibility as the luminous or colorific rays, as they are now sometimes, for distinction, called. And from this, another curious consequence, of great importance and interest to the Daguerreotypist and photographist, follows, which is, that the focus of the colorific rays is not identical with that of the photogenic rays. When the camera, therefore, is so adjusted as to produce a distinct optical picture upon a plate of ground glass placed in the groove intended to receive the photographic plate or paper, the photographic picture will not, when produced there, be in focus. To bring it into focus, the object-glass must be moved through a space equal to the distance between the foci of the colorific and the photogenic rays.

Instruments, called *Focimeters,* have been contrived, for the purpose of enabling the photographist to make this adjustment, one of which is due to M. Claudet, for which, together with other ingenious improvements, he has received the council medal. The principle of the instrument consists in placing before the camera, at the same moment, a circular arrangement of cards formed into segments, each segment being at a different distance from the lens. A photographic picture of all these is simultaneously produced. The picture of some one among them will always be found to be more distinct than those of the others, and it follows that the plate or paper is in the photogenic focus corresponding to that one.

Another apparatus, not less ingenious and effective, has been invented and applied with complete success, to determine the photogenic focus, by Mr. G. Knight. He places

the photographic plate or paper in an inclined groove, so that different parts of it are at different distances from the lens. A printed sheet being placed before the camera, a picture will be produced, on which the lines of print will be more or less distinct. The line which is most distinct determines the point of the plate, or of the inclined groove, which coincides with the photogenic focus.

There is no question connected with photography which the public regards with so much interest as that which refers to the possibility or probability of producing sun-drawn pictures of objects in their natural colours. Some of the consequences to which we have just referred, and which have established the conclusion that the rays by which photographic pictures are produced are rays of *dark light*, and are distinct from the colorific rays, are certainly unfavourable, *primâ facie*, to this expectation. Nevertheless, it is certain that within the last two years Sir John Herschel succeeded in obtaining a coloured picture of the prismatic spectrum, and, in a recent letter addressed by him to Professor Hunt, he affirms that he had specimens of coloured pictures of the spectrum, in light colours on a dark ground, and adds that at present he is "not prepared to say that this will prove an available process for coloured photographs, *though it brings the hope nearer*." *

Professor Hunt himself says that he has obtained beautiful coloured pictures of the spectrum upon Daguerreotype iodidated tablets, on which the colours had peculiar softness and brilliancy. M. Edmund Becquerel is stated to have obtained recently bright impressions in colours. Mr. Hill, of New York, affirms that he has obtained more than fifty pictures from nature, in all the beauty of natural coloration. The process by which this is said to have been effected is

* Professor Hunt's Treatise on Photography, p. 219.

not disclosed, but is said to be a modification of Daguerreotype, one material, however, altogether new, having been introduced. It is said that the process will be made public so soon as the manipulatory details have been perfected.

Although our limits exclude us from entering into the details of some other wondrous facts, which the untiring researches of scientific men have disclosed in this department of physics, we must not omit to mention that M. Moser, of Konigsberg, has shown that light constantly emanates from all bodies, even *in complete darkness*, and that when placed near each other they receive upon their surfaces reciprocally *pictures* of each other. These photographic pictures, however, are invisible, and continue to be so until they are developed by the application of certain vapours, such as that of water, mercury, iodine, &c.

These marvellous discoveries of M. Moser have been fully confirmed by other more recent inquirers.

Attempts have been recently made, with more or less success, to remove the metallic or *leaden* hue which has been found disagreeable in Daguerreotype portraits. This is effected by colouring them by means of dry colours rubbed into the incisions made by the action of the light. These coloured Daguerreotypes, though more open to objection on artistical grounds, are, nevertheless, decidedly popular, when judiciously executed.

Artists, and especially miniature painters, are naturally opposed to Daguerreotype. No miniature, however, will, so far as relates to mere resemblance, bear comparison to a Daguerreotype. *The artist* can soften down defects, and present the sitter under the most favourable aspect. *The sun*, however, is no flatterer, and gives the lineaments as they exist, with the most inexorable fidelity, and the most cruel precision.

Nevertheless, it is known that some of the most eminent portrait painters—those whose productions have raised them above petty feelings—do avail themselves of the aid of Daguerreotypes, where well-executed representations of that kind are obtainable; and they see in this no more degradation of their art, than a sculptor finds in using a *cast* of the subject which his chisel is about to reproduce.

4. Lightning Conductors.

Of all the gifts which Science has presented to Art in these latter days, the most striking and magnificent are those in which the agency of electricity has been evoked.

From the moment electric phenomena attracted the attention of the scientific world, the means of applying them to the useful purposes of life were eagerly sought for. Although such applications had not yet entered into the spirit of the age as fully as they have since done, it so happened that, in this department of physics, a volunteer had enlisted in the army of science, the characteristic of whose genius was eminently practical, and soon achieved, by his discoveries, an eminence to which the world has since offered universal homage. Benjamin Franklin, a member of a literary society in Philadelphia, had his attention called to the then recent discovery, the phenomena of the Leyden Jar, which astonished all Europe. From that moment the views of Franklin were bent on the discovery of some useful purpose to which these phenomena could be rendered subservient. *Cui bono?* was a question never absent from his thoughts. After having made some of these great discoveries which have since formed the basis of electrical science, and have surrounded his name with unfading lustre, he expressed,

in a letter to the secretary of the Royal Society of London, in his usual playful manner, his disappointment at not being yet able to find any application of the science beneficial to mankind:—

"Chagrined a little," he wrote, "that we have hitherto been able to produce nothing in the way of use to mankind; and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for the season, somewhat humourously, in a party of pleasure, on the banks of the Schuylkill.* Spirits, at the same time, are to be fired by a spark sent from side to side, through the river, without any other conductor than the water; an experiment which we some time since performed to the amazement of many.† A turkey is to be killed for dinner by the electrical shock, and roasted by the electrical jack ‡, before a fire kindled by the electrical bottle" (since known as the Leyden phial), "when the healths of all the famous electricians in England, Holland, France, and Germany, are to be drunk in electrified bumpers, under the discharge of guns from the electrical battery." §

Although the application of the great principles of science to the practical uses of life cannot be too highly appreciated, it would be a great error to carry this enthusiasm for the

* A picturesque river which washes the western suburbs of Philadelphia, and to the valley of which it is the custom of the citizens to make pic-nic parties. In the summer months, the temperature at Philadelphia is so high as to banish to the watering-places all who are not absolutely tied to the town by the exigencies of their business.

† This experiment has been recently reproduced in the investigations connected with the electric telegraph, but without giving credit to Franklin as its original author.

‡ It will be seen by this hint that the idea of applying electricity, as a moving power, had already occurred to Franklin.

§ Franklin's Works, vol. v. p. 210. Boston, 1837.

useful to such an excess as to exclude a just admiration for those high abstract laws, the discovery of which had conferred lustre on the names of our greatest philosophers, and on none more justly than that of Franklin himself. It must be admitted, however, that this craving after utility was the leading characteristic of his mind, and may even be regarded as having been carried almost to a fault.

Although the application of the properties of matter and the phenomena of nature to the uses of civilised life is undoubtedly *one* of the great incentives to the investigation of the laws of the material world, yet it is assuredly a great error to regard that either as the only or the principal motive to such inquiries. There is in the perception of truth itself—in the contemplation of connected propositions, leading by the mere operation of the intellectual faculties, exercised on individual physical facts, to the development of those great general laws by which the universe is maintained—an exalted pleasure, compared with which the mere attainment of convenience and utility in the economy of life is poor and mean. There is a nobleness in the power which the natural philosopher derives from the discovery of these laws, of raising the curtain of futurity and displaying the decrees of nature, so far as they affect the physcal universe for countless ages to come, which is independent of, and above all utility. While, however, we thus claim for truth and knowledge all the consideration to which, on their own account, they are entitled, let us not be misunderstood as disparaging the great benefactors of the human race, who have drawn from them those benefits which so much tend to the well-being of man. When we express the enjoyment which arises from the beauty and fragrance of the flower, we do not the less prize the honey which is extracted from it, or the medicinal virtues which it yields. That Franklin

was accessible to such feelings, the enthusiasm with which he expresses himself throughout his writings, in regard to natural phenomena, abundantly proves. Nevertheless, *useful application* was undoubtedly ever uppermost in his thoughts; and he probably never witnessed a physical fact, or considered for a moment any law of nature, without inwardly proposing to himself the question, "In what way can this be made beneficial in the economy of life?"

After studying the properties of metals, in virtue of which electricity runs along them in preference to other substances, and discovering the property of points to attract the electric fluid, Franklin proceeded at once to the discovery of conductors, or "lightning-rods," for the protection of buildings.

"If these things be so," wrote he, "may not the knowledge of this power of points be of use to mankind in preserving houses, churches, ships, &c., from the stroke of lightning, by directing us to fix on the highest points of those edifices upright rods of iron made sharp as a needle, and gilt (at the points) to prevent rusting; and from the foot of those rods a wire down the outside of the building into the ground, or down round one of the shrouds of a ship, and down her side till it reaches the water? Would not these pointed rods probably draw the electric fire out of a cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible mischief?"

It is known to every one, that after this Franklin established his theory by the celebrated experiment of the kite, by which he literally drained a cloud of its lightning; but what is not so well known is, that when the paper written by Franklin, explaining his project of constructing lightning-conductors for the protection of buildings, was soon afterwards read before the Royal Society of London, it was received with peals of laughter, and was voted so absurd as

to be deemed unworthy of being printed in the "Philosophical Transactions." It was, however, printed by an independent publisher, and attained a world-wide celebrity.

Not long afterwards, the same members of the Royal Society who laughed at Franklin's project, were called upon to superintend the erection of conductors upon the royal palace, when, to gratify the royal spleen against the rebellious philosopher of the revolted colonies, they rejected the *pointed conductors* recommended by Franklin, and actually caused *blunt conductors* to be placed on the palace!

One of the most recent, and, in many points of view, the most important improvement in practical detail, which Franklin's invention has received, is the form in which it has been applied to the protection of ships by Sir William Snow Harris, who has received for it the council medal. His arrangement was adopted generally by the Admiralty some years ago for the Royal Navy, since which time not a single instance of damage arising from lightning has been recorded, although many cases have occurred of ships being struck.

This apparatus consists of a pointed conductor securely screwed on to the top or royal mast of the vessel. This rod is in metallic contact with a series of bars of metal carried down the masts and through the deck to the *step* and *keelson*, in which the mast is fixed. The line of metallic conduction is thence continued by various bars and bolts to the sea, which is thus rendered the ultimate recipient of the electric fluid.

Contrivances are provided, at the places where the masts slide one upon the other, to prevent the metallic contact from being for a moment broken by any of the contingencies of the navigation. Meanwhile, the series of conductors is independent of the officers and crew, so that the sailors are never required to handle or replace them, a proceeding

which, in certain electrical conditions of the atmosphere, would be perilous in the extreme. They are also completely clear of the standing and running rigging, and while they are capable of resisting any external violence to which they may be exposed, they are also capable of yielding to any flexure or strain to which the spars that carry them are exposed. In fine, their disposition and arrangement is such, that lightning striking the ship shall have no alternative save to flow quietly along them, and pass into the sea. In relation to the electric fluid, the ship is therefore practically as safe from explosion as if it were composed of a solid mass of metal.

The following extract from the official journal of H. M. S. Conway, 28, is given as an example of the efficacy of this system:—

"Port Louis, Isle of France, 9th March, 1846, 11·45 A.M. The pendant staff at maintop mast-head was shivered to pieces by lightning, Harris's conductor carrying off the fluid without further damage."

In this case the ship was refitting, and the topmasts on deck, so that a small spar was erected as a temporary support for the pendant, which, consequently, was not provided with the conducting rod. The remainder of the series of conductors being permanently fixed in the masts, were, however, present. The spar being a non-conductor, or rather an imperfect conductor, was shivered in pieces, owing to the resistance it presented to the transit of the lightning; but the moment the fluid reached the conductor below the spar attached to the masts, it flowed quietly to the keel, and thence to the water.

The sound of the thunder was stated, in this case, to have been similar to the report of one of the main-deck guns. The gunner, who was sitting in his berth, immediately

under one of the lateral branches of the conductor, saw, through the scuttle port, a brilliant blaze of light issue between the ship and the sea, produced obviously by the passage of the electric fluid from the metallic conductor to the water, the explosion, in this case, arising from the passage from a perfect to an imperfect conductor.

It might have been expected that the gunner, in this case, would have felt the secondary or inductive shock. This, however, did not happen. He was sensible of no inconvenience.

5. The Safety-Lamp.

Art often presses into its service the discoveries of Science, but it sometimes provokes them. Art surveys the fruit of the toil of the philosopher, and selects such as suit her purposes; but sometimes, not finding what meets her wants, she makes an appeal to Science, whose votaries direct their researches accordingly towards the desired object, and rarely fail to attain it.

One of the most signal examples of the successful issue of such an appeal presents itself in the *Safety-lamp*.

The same gas which is used for the purposes of illumination of our cities and towns (and which, as has been stated, is obtained from coals by the process of baking in close retorts), is often spontaneously developed in the seams of coal which form the mines, and collects in large quantities in the galleries and workings where the coal-miners are employed. When this gas is mingled with common air, in a certain definite proportion, the moisture becomes highly explosive, and frequently catastrophes, attended with frightful loss of life, occur in consequence in the mines. The prevalence of this evil became so great, that Government called

the attention of scientific men to the subject; and the late Sir Humphry Davy engaged in a series of experimental researches with a view to the discovery of some efficient protection for the miner, the result of which was the now celebrated Safety-lamp.

Davy first directed his inquiries to the nature and properties of flame. What is flame? was a question which seems until then never to have been answered or even asked.

All known bodies, when heated to a certain intensity, become luminous. Thus iron, when its temperature is elevated, first gives a dull red light, which becomes more and more white as the temperature is increased, until at length it becomes as white as the sun. Davy showed that gaseous substances are not exempt from this law, and that flame is nothing more than *gas* rendered *white hot*.

He further showed that if the gas thus rendered white hot be cooled, it will cease to be luminous in the same manner, and from the same cause, as would be the case with a red hot poker plunged in water.

He showed that the gas which forms flame may be cooled by putting it in contact with any substance, such as metal, which is a good conductor.

Thus, if a piece of wire net-work, with meshes sufficiently close, be held over the flame of a lamp or candle, it will be found that the flame will not pass through the meshes. The wire will become red hot, but no flame will appear above it.

It is not, in this case, that the gas which forms the flame does not pass through the meshes of the wire, but, in doing so, it gives up so much of its heat to the metal, that when it escapes from the meshes above the wire, it is no longer hot enough to be luminous.

Sir Humphry Davy, in the researches which he was called to make, discovered this important fact, which enabled

him to explain the nature and properties of flame; and having so discovered it, he did not fail promptly to apply it to the solution of the practical problem with which he had to grapple.

This problem was, to enable the miner to walk, lamp in hand, through an atmosphere of highly explosive gas, without the possibility of producing explosion. It was as though he were required to thrust a blazing torch through a mass of gunpowder, without either extinguishing the flambeau or igniting the powder; with this difference, however, that the gaseous atmosphere to which the miner was often exposed was infinitely more explosive than gunpowder.

The instrument by which he accomplished this was as remarkable for its simplicity as for its perfect efficiency. A common lantern, containing a lamp or candle, instead of being as usual enclosed by glass or horn, was enclosed by wire gauze of that degree of fineness in its meshes which experiment had proved to be impervious to flame. When such a lantern was carried into an atmosphere of explosive gas, the external atmosphere would enter freely through the wire gauze, and would burn quietly within the lantern; but the meshes which thus permitted the cold gas to enter, forbid the white-hot gas within to escape without parting with so much of its heat in the transit as to deprive it of the character and properties of flame; so that, although it passed into the external explosive atmosphere, it was no longer in a condition to inflame it.

The lamp thus serves a double purpose: it is at once a *protection* and a *warning*. It protects, because the flame within cannot ignite the gas outside the lantern. It warns, because the miner, seeing the gas burning within the lantern, is informed that he is enveloped by an explosive atmosphere,

and takes measures accordingly to ventilate the gallery, and meanwhile to prevent unguarded lights from entering it.

Nothing can be imagined more triumphantly successful than this investigation of Sir Humphry Davy. Some philosophers have the good fortune to arrive at great scientific discoveries in the prosecution of those inquiries to which the course of their labours leads them. Some are so happy as to make inventions of high importance in the arts, when such applications are suggested by the laws which govern the phenomena that have arisen in their experimental researches. But we cannot remember any other instance in which an object of research being proposed to an experimental philosopher, foreign to his habitual inquiries, having no associations with those trains of thought in which his mind has been previously involved, he has prosecuted the inquiry so as to arrive not only at the development of a natural law of the highest order, the fruitful parent of innumerable consequences of great general importance in physics, but, at the same time, to realise an invention of such immense utility as to form an epoch in the history of Art, and to become the means of saving countless numbers of human lives.

6. Needle-grinder's Mask.

As wire gauze drains flame of its danger in the safety-lamp, it drains air of its poison by another felicitous application of a physical principle in the case of the needle-grinder's mask. In that department of industry, the health of the artisan was impaired, and the duration of his life abridged, by respiring continually, while at work, an atmosphere impregnated with steel dust. A mask was invented composed of a gauze formed of magnetised wire, through

which the artisan was to breathe. The air, in passing from the external atmosphere to the mouth and nostrils, left all the steel dust, which it held in suspension, on the wire of the mask, from which, from time to time, it was wiped off as it accumulated.

7. Electro-Metallurgy.

Of all the discoveries which have rewarded the labours of physical inquirers, that which has been most fertile in benefits conferred upon the arts of life, has been Electricity. Common electricity had scarcely been discovered, and its laws as yet but imperfectly understood, when it was rendered the means of defence and protection against the most terrible of meteors. The discovery of galvanism (1789), immediately followed by the invention of the pile (1800), produced consequences which revolutionised several of the most important branches of metallurgic industry, and conferred upon society an instrument of intercommunication, the powers of which transcend the limits even of fiction.

Natural substances are endowed with properties having relation to the poles of a voltaic pile, in virtue of which some are attracted by the positive and repelled by the negative pole; while others are, on the contrary, attracted by the negative and repelled by the positive pole. The former are called negative and the latter positive substances.

When a compound body consists of two constituents, one of which is electrically positive and the other negative, they are combined together by the attraction which always attends these opposite electrical conditions. But if such a compound be placed under the operation of the poles of a voltaic pile, the positive pole will attract the negative and repel the positive constituent, and the negative pole will attract the positive and repel the negative constituent. The result will

be a tendency, produced by the action of the pile, to separate the constituents, and consequently to decompose the compound. If the forces exerted by the pile be more energetic than the attraction by which the constituents are united, decomposition will actually ensue, the negative constituent passing to the positive pole, and the positive to the negative pole.

The application of these principles in the improvements which have been effected in metallurgic operations, depends on the following facts:—

1st. Any body which is a conductor of electricity may be adopted as a pole of the pile, by merely connecting it by a metallic wire with one or other extremity of the pile.

2nd. The metals are all electro-positive substances, and are therefore attracted by the negative, and repelled by the positive pole of a pile.

3rd. The action of the poles of a pile may be directed upon solids by dissolving them in liquids, and immersing the poles of the pile in the solution. By the processes of chemistry all the metals may be thus dissolved, and therefore submitted to the electro-metallurgic processes.

Such, in brief, are the principles from the successful practical application of which have resulted those vast branches of industry, which supplied the chief part of the magnificent display witnessed with so much admiration in the south central gallery of the Crystal Palace, besides large collections exhibited in several of the foreign departments.

When it is desired to produce, by the electric process, an article in solid metal, it is necessary to provide a metallic mould of the article, and a solution of the metal of which it is desired to form it.

The mould, being connected by a wire with the negative end of a voltaic battery, becomes its negative pole, and, being

immersed in the solution (which is also in communication with the positive pole of the battery), decomposition ensues. The metal is attracted from the solution, and collects upon the surface of the mould, and this process is continued until the mould is filled to the necessary depth. The process being finished, the mould is withdrawn from the solution, and the metal deposited upon it is detached from it.

If the object which it is desired to copy by the electric process be itself metallic, a metallic mould may be made from it by the electric process itself.

Let the object—suppose it, for example, a coin or a medal—be covered on the side not intended to be moulded, with bees' wax or tallow, and let the face to be moulded be well cleaned with sweet oil, or brushed over with black lead. The purpose of this preparatory process is to prevent the metal deposited by the electric process from adhering to the coin. The coin thus prepared being connected with the negative end of the battery, and immersed in a solution of the metal of which the mould is to be formed, which is connected with the positive end, deposition will take place upon the face of the coin, which, having attained sufficient thickness, is detached, and the mould is complete.

From the mould thus produced other coins may be formed, and from them other moulds produced, so that the article once existing may be perpetuated, each article thus obtained being identical, in its most minute details, with the others, and with the original.

In this manner any article being obtained upon which the greatest amount of artistic labour has been expended may be multiplied indefinitely, at a cost not much exceeding that of the materials consumed in the process.

It is not necessary that either the original or the mould shall be in metal; they may be formed in wood, plaster of

Paris, wax, or any other material which the artist may find most convenient. It is only necessary, when the object to be copied is not metallic, to brush over its surface with black lead. This gives it all the conducting power which is necessary to produce the metallic deposition upon it.

Electro-plating and gilding, or, to speak more generally, the process of depositing a coating of one metal upon an object composed of another, is accomplished upon the same principle. The object to be coated, connected with the negative end of the battery, is immersed in a solution of the metal with which it is to be coated, and the process goes on as already described; but in this case the surface of the object is not prepared as when a mould is required, so as to prevent adhesion, but, on the contrary, rather so as to favour it.

Copper moulds, produced by the processes here described, are extensively used, to make fac-similes in the precious metals of objects upon which the highest artistic skill has been lavished. Duplicates of highly-wrought work, either chased or engraved, or of articles which are unique,—such as antiques,—may thus be multiplied indefinitely in gold or silver, at a cost not much exceeding that of the metal of which they are composed. A large part of the articles in the precious metals which furnished the galleries of the Exhibition were produced by this process. A considerable trade is also carried on in figures, and other works of art produced in copper, subsequently bronzed by this process, by which they acquire an appearance not inferior to the most esteemed antiques.

It is obviously possible, by various expedients which will occur to any practical mind, to deposit different metals on different parts of the same metallic object, so as to gild one part, plate another, platinise a third, cuperise a fourth, and

so on. By such methods the following metals have been deposited, in this manner, on metallic or other conducting surfaces: gold, platinum, silver, copper, zinc, nickel, antimony, bismuth, cobalt, palladium, cadmium, lead, and tin. The varieties of workmanship which result from this must be obvious. The gilding solutions may be made by dissolving slips of gold in a solution of cyanide of potassium, and attaching to the negative pole of the voltaic battery a small plate of gold, and to the positive pole a much larger one. By these means the latter combines with the cyanogen under the influence of positive electricity, and forms the solution.

Oxide of gold may also be precipitated from the chloride by magnesia, and dissolved in the solution of the cyanide.

It is only within the last ten years that this new metallurgic art has been practised. Within a few years, however, this manufacture has made immense progress, more especially in the hands of Messrs. Elkington & Co., who have obtained by it a world-wide celebrity.

Before this the art of attaching a surface of precious metal to the baser metals consisted in soldering a plate of gold or silver upon a thicker plate or bar of copper or iron, and submitting the compound mass to the rolling process. It is evident that this process would not be applicable to mouldings and chasings, and these were accordingly made solid, or stamped hollow in the precious metal and filled with some baser fusible metal.

The ornamentation of the article in the old method of plating, which is not yet totally abandoned, is produced by stamping leaf silver with steel dies, representing the ornament required, the hollow leaf thus produced being filled up with a fusible alloy, composed of lead and tin. The ornaments thus produced are then soldered upon the plated surface of the article with soft solder. What are called silver

edges and mountings are thus produced. The quality of the article depends on the thickness of the leaf silver used.

The advantages claimed for the modern art of electroplating and gilding over the former process, are—

1st. In the electric process we are not, as in the old process, limited to copper as a base, but can use a white metal called German silver, composed of copper, nickel, and zinc, and which approximates to silver in hardness, sound, and colour.

2nd. We are not restricted to the use of soft solder to unite the parts; all well-made goods are united with silver solder, which makes a joint as strong as the metal itself; or the article may be brazed.

3rd. There is no restriction as to form; the most elaborate ornaments, and the most expensive designs that can be produced in silver, are obtained with facility by this process. There is no expense of cutting steel dies for every ornament. The manufacturer models his pattern according to any required design, and by casting and chasing in solid metal produces an exact copy, which is afterwards plated or gilt.

4th. The plating is permanent; the silver coating becoming, by the agency of electricity, one body with the metal on which it is deposited. Economy in the first cost, durability, the power of multiplying indefinitely, at an insignificant cost, works of art of the highest excellence, the production, with equal precision and perfection, of copies of the smallest gems and the largest statues, retaining all the accuracy and beauty of the originals.

Among the exhibitors in this department of the art, Messrs. Elkington & Co., as might be expected, stood among the foremost for the number, variety, and beauty of the productions offered to public admiration; and the council medal has been most deservedly awarded to them for their improve-

ments generally in the electro-metallurgic art. Among the objects exhibited by them, a vase in silver, illustrative of the objects of the Great Exhibition, merits especial notice. The triumph of science, applied to the industrial arts, is typified. Four statuettes around the body of the vase represent Newton, Bacon, Shakspeare, and Watt. Four bas-reliefs between the figures represent practical operations of Science and Art. The vase is surmounted by a statuette of Prince Albert awarding the palm of honour to successful industry. The height of this vase is four feet.

Besides the large and beautiful collection of productions of art exhibited by Messrs. Elkington & Co., Her Majesty exhibited the two following splendid articles of their fabrication: —

1. Jewel-case in bronze, gilt and silvered by the electrotype process, designed by Gruner, in the cinque-cento style, containing portraits and profiles of the royal family.

2. Table of gold and silver electro-plate; the top an electrotype reproduction of a plate obtained and copied by the Chev. de Schlick subjects in bas-relief. Minerva, Astrologia, Geometrica, Arithmetica, Musica, Rhetorica, Dialectica, and Grammatica; centre Temperance and the Four Elements: the Table designed by George Stanton.

As might be expected, Messrs. Hunt and Roskell (the successors of Storr and Mortimer) were the most considerable exhibitors in ornamental works in the precious metals; the number of objects presented by them being nearly 100 among which are many of great magnitude, beauty, and value.

One of these is a piece of work in silver, showing its application to sculpture combined with the metallurgical art.

The groups of figures represent the Seasons, the Quarters of the Globe, and the Elements. The *alti relievi* represent Day and

Night. This work has been both designed and modelled by Mr. A. Brown.

Another fine piece of artistic work exhibited by the same firm is a testimonial in silver presented to Sir Moses Montefiore. The sphynxes are indicative of the captivity of the Israelites in Egypt; the figures represent Moses and Ezra, the great deliverers of their people. A Jew of Damascus is represented in chains, and another released. Under these are appropriate texts in Hebrew, the vine and fig tree overshadowing. The group on the summit of the work represents David rescuing the lamb from the jaws of the lion; the bas-reliefs represent the passage of the Red Sea and the destruction of Pharaoh's host. Lawless violence in the world is typified by wolves devouring flocks. Sir Moses and Lady Montefiore are represented landing at Alexandria and obtaining a *firma*. This fine piece of work has been modelled from designs by Sir George Hayter.

Among the articles presented by the same house were two very beautiful equestrian statuettes of Napoleon and the Duke of Wellington, by Count d'Orsay. These have been executed in solid silver gilt, and are the property of the Duke of Wellington.

The same house exhibited a splendid centre piece, representing Asia crowning Britannia on a pedestal of Indian architecture, with palm trees at the angles. The treaty of Nankin, and views of Calcutta, Cabul, and Canton, are represented in bas-reliefs; figures of Affghan and Chinese captives and a British Sepoy complete the groups, the whole being supported by recumbent elephants.

Among the objects exhibited by this firm which will be viewed with the most interest, is a silver cup, the last work of that kind which was superintended by Chantrey. It was presented to Charles Kemble on his retirement from the stage. The frieze represents the Seven Ages, the figure of Kemble as Hamlet being placed on the summit.

A testimonial is also exhibited which was presented to Mr. Lumley, the director of Her Majesty's Theatre, modelled and designed by Mr. Brown. The figures upon this work of art represent Melpomene, Thalia, Terpsichore, and Euterpe.

The same house also exhibited a magnificent shield, in silver, given as a prize by the Emperor of Russia at the Ascot races of 1848. This work, designed and modelled by Mr. Brown, represents the principal incidents in the life of Peter the Great. In the centre Peter is represented triumphing over Ignorance, Vice, and Envy. The six compartments, divided by figures of Victory, represent so many incidents in the life of the Czar. One exhibits his deliverance from the insurrection of the Shillitz; and in another he is represented working as a shipwright in Deptford dockyard; another represents the foundation of St. Petersburgh; another celebrates his clemency at the taking of the Neva; the fifth represents Catherine and Peter at the Battle of Pruth; and the sixth represents the Czar crowning Catherine as Empress.

The council medal has been awarded to Messrs. Hunt and Roskell for a vase by Vechte, of which the following description appears in the Official Catalogue: —

A vase of Etruscan form, embossed from thin sheets of silver in the highest and lowest possible relief. The subject, which is treated in the style of Michael Angelo, is the destruction of the Titans by Jupiter, who made war upon them for having imprisoned his father Saturn. The giant sons of Cœlus and Terra, seeking to revenge the death of the Titans, made war upon the gods, heaped rock upon rock, mountain on mountain,—'Ossa on Pelion piled,'—in order to reach heaven. Jupiter routed his foes, who were crushed under rocks and mountains. On the summit of the cover is Jupiter, who, with stern and angry looks, grasps thunderbolts, which he hurls on the presumptuous Titans below. Bordering the cover is the zodiacal circle in low relief. On the body of the vase, on each side, are groups of giants, some climbing upwards, some crushed by the rocks hurled by mighty Jove. Supported by the handles of the vase, two bold presumptuous giants stand out in full relief, vainly menacing the father of gods and men. On the foot are fallen distorted figures, representing Vice and Presumption writhing in the agonies of death. On the neck of the vase, in bas-relief, are two figures representing Time and

Fate, the former with his scythe, the latter grasping serpents. Among the representations in low relief may be recognised Satyrs and Bacchanals in bowers of vine; Neptune in his chariot, drawn by sea-horses, hurling thunderbolts at the giants who cast rocks at him; flies and grotesque insects writhe in a spider's web, alluding to the fate of Arachne. Below one of the handles is Pan, beneath the other a skeleton. Crocodiles, winged serpents, fiery dragons, and other fabulous monsters of sea and land, wage war with one another.

The electro-metallurgic processes have been extended by ingenious contrivances to other substances besides metal. Thus a coating of metal may be deposited on cloth, lace, or other woven fabric, by various ingenious expedients, of which the following is an example: — On a plate of copper attach smoothly a cloth of linen, cotton, or wool, and then connect the plate with a negative pole of a voltaic battery, immerse it in a solution of the metal with which it is to be coated, and connect a piece of the same metal with the positive pole; decomposition will then commence, and the molecules of metal, as they are separated from the solution, must pass through the cloth in advancing to the copper to which the cloth is attached. In their passage through the cloth they are more or less arrested by it. They insinuate themselves into its pores, and, in fine, form a complete metallic cloth. Lace is metallised in this way by first coating it with plumbago, and then subjecting it to the electro-metallurgic process.

Quills, feathers, flowers, and other delicate fibrous substances may be metallised in the same way. In the case of the most delicate of these the article is first dipped into a solution of phosphorus and sulphurate of carbon, and is well wetted with the liquid. It is then immersed in a solution of nitrate of silver. Phosphorus has the property of reviving silver and gold from their solutions. Consequently, the

article is immediately coated with a very attenuated film of the metal, and if it be connected with a galvanic battery, it may be coated to any thickness with silver, gold, or copper.

Mr. Alexander Watt exhibited quill pens thus gilt and silvered by electro-chemical agency, the nibs being tipped with rhodium so as to unite the advantages of the gold pen with the elasticity of the quill. He also exhibited ostrich feathers and various similar articles gilt and silvered by the same process.

One of the most remarkable and unexpected applications of the electrotype process is to Daguerreotypes. The picture being taken upon the plate by the usual process of Daguerreotype, a small part of the back is cleaned with sand paper, taking care not to allow the face of the plate to be touched. A piece of wire is then soldered to the part of the back thus prepared. The plate is then immersed in a solution of copper, and connected with the battery, the back being, as in the case of a medal, protected by a coating of wax. After a deposit of sufficient depth has been made upon the face of the plate, it is withdrawn from the solution and the plate of copper deposited being detached, exhibits the picture with an expression softer and finer than the original. By this process when conducted with skill, several copies may be taken from the same Daguerreotype.

If the electrotype copy thus obtained be passed through a weak solution of the cyanide of gold and potassium in connection with a weak battery, a beautiful golden tint will be imparted to the picture, which serves to protect it from being tarnished.

Specimens of electrotype copies of Daguerreotypes obtained by this process, were exhibited by Messrs. Griffiths and Le Beau.

The electro-metallurgic art, notwithstanding the number,

variety, and beauty of its products, is still only in its infancy, and scarcely a month passes which does not disclose new and unexpected uses to which its application is extended. In its earlier use, its application was limited to the combination of one metal with another, and it was assumed that metallic objects only could be gilt, plated, cuperised, platinised, &c. by this process. The invention of the methods of coating non-metallic objects produced an immense extension of the uses of this art, and it is difficult now to say what may be its limits. As examples of the variety of the applications of which it is susceptible, we may mention that at a trifling cost it has been applied to impart a coating of copper to cornices for the decoration of buildings, to terra cotta carvings in wood, &c.; cloth, leather, and lace have received metallic coatings with a curious, beautiful, and useful effect.

A process called Glyphography, has been invented by Mr. Palmer, which bears some analogy to the method of copying Daguerreotypes already described. The principle of glyphography consists in depositing upon a plate of metal a thin stratum of wax, or any other soft substance, on which a subject or design is engraved, the depth of the incisions being determined by the thickness of the soft coating. When the engraving is thus made, it is subjected to the electrotype process, by which a sheet of copper or other suitable metal is deposited upon it. When this is detached, it will exhibit in relief the engraving, and printed impressions may be produced from it in the same manner as from a wood-cut, to which it is altogether analogous.

Engravings made on copper or steel may be indefinitely multiplied by the electrotype process. A mould is first taken from the engraved plate on which the engraving is produced in relief. From this, any number of plates identical with the original can be made by the process already described.

8. The Electric Telegraph.

Of all the applications of electric agency to the uses of life, that which is transcendently the most admirable in its effects, and the most important in its consequences, is the Electric Telegraph. No force of habit, however long continued, no degree of familiarity can efface the sense of wonder which the effects of this most marvellous application of science excite.

Happening lately to visit Paris, we assisted at some experiments which were made at the bureau of telegraphs at the Ministry of the Interior. There we found ourselves in a room about twenty feet square, in the presence of some half-dozen persons seated at desks, employed in transmitting to, and receiving from, various distant points of France, despatches. Being invited, we dictated a message, consisting of about forty words, addressed to one of the clerks at the railway station at Valenciennes, a distance of 168 miles from Paris. This message was transmitted in two minutes and a half. An interval of about five minutes elapsed, during which, as it afterwards appeared, the clerk to whom the message was addressed was sent for. At the expiration of this interval the telegraph began to express the answer, which, consisting of about thirty-five words, was delivered and written out by the agent at the desk, in our presence, in two minutes. Thus, forty words were sent 168 miles, and thirty-five words returned from the same distance, in the short space of four minutes and thirty seconds.

But surprising as this was, we soon afterwards witnessed, in the same room, a still more marvellous performance.

The following experiment was prepared and performed at the suggestion and under the direction of M. Le Verrier,

the celebrated astronomer, and Dr. Lardner, and in the presence of a Committee of the Legislative Assembly, M. Pouillet, professor of physics, and several distinguished members of the Academy of Sciences:—

Two telegraphic wires, extending from the Ministry of the Interior to Lille, were united at the latter place, so as to form one continuous wire, extending from the Ministry to Lille, and back from Lille to the Ministry, making a total distance of 336 miles. This, however, not being deemed sufficient for the purpose, several spiral coils of wire, wrapped with silk, were obtained, measuring in their total length 746 miles, and were joined to the extremity of the wire returning from Lille, thus making one continued wire measuring 1082 miles. A message consisting of 282 words was now transmitted from one end of the wire. A pen attached to the other end immediately began to write the message on a sheet of paper, moved under it by a simple mechanism, and the entire message was written in full in the presence of the Committee, each word being spelled completely and without abridgment, in *fifty-two seconds*, being at the average rate of *two words and four-tenths per second!*

By this instrument, therefore, it is practicable to transmit intelligence to a distance of upwards of 1000 miles, at the rate of 19,500 words per hour!

The instrument would, therefore, transmit to a distance of 1000 miles, in the space of an hour, the contents of sixty pages of the book now in the hands of the reader!

But it must not be imagined, because we have here produced an example of the transmission of a despatch to a distance of 1000 miles, that any augmentation of that distance could cause any delay of practical importance. Assuming the common estimate of the velocity of electricity, the time which actually elapsed in the transmission of the

despatch in this case was the two-hundredth part of a second. If, therefore, instead of sending the despatch along 1000 miles of wire, we had sent it along a wire completely surrounding the globe, the time of its transmission would still be only the *eighth part of a second.*

Such a despatch would fly eight times round the earth between the two beats of a common clock, and would be written in full at the place of its destination more rapidly than it could be repeated by word of mouth. When such statements are made do we not feel disposed to exclaim—

> "Are such things here as we do speak about?
> Or have we eaten of the insane root,
> That makes the reason prisoner?"

In its wildest flights the most exalted imagination would not have dared, even in fiction, to give utterance to these stubborn realities. Shakspeare only ventured to make his fairy

> "Put a girdle round the earth
> In forty minutes."

To have encircled it eight times in a second, would have seemed too monstrous, even for Robin Goodfellow.

The curious and intelligent reader of these pages will scarcely be content, after the statement of facts so extraordinary, to remain lost in vacant astonishment at the power of science, without seeking to be informed of the manner in which the phenomena of nature have been thus wonderfully subdued to the uses of man. A very brief exposition will be enough to render intelligible the manner in which these miracles of sciences are wrought.

The electric telegraph, whatever form it may assume, derives its efficiency from the three following conditions:—

1. A power to develop the electric fluid continuously, and in the necessary quantity.

2. A power to convey to it any required distance without being injuriously dissipated.

3. A power to cause it, after arriving at such distant point, to make written or printed characters, or some sensible signs serving the purpose of such characters.

The apparatus from which the moving power by which these effects are produced is derived, is the voltaic pile or galvanic battery. This is to the electric telegraph what a boiler is to a steam engine. It is the generator of the fluid by which the action of the machine is produced and maintained.

We have therefore first to explain how the electric fluid, generated in the apparatus just explained, can be transmitted to a distance without being wasted or dissipated in any injurious degree *en route*.

If tubes or pipes could be constructed with sufficient facility and cheapness, through which the subtle fluid could flow, and which would be capable of confining it during its transit, this object would be attained. As the galvanic battery is analogous to the boiler, such tubes would be analogous in their form and functions to the steam-pipe of a steam engine.

The construction of such means of transmission has been accomplished by means of two well-known properties of the electric fluid, in virtue of which it is capable of passing freely over a certain class of bodies called *conductors*, while its movement is arrested by another class called *non-conductors*, or *insulators*.

The most conspicuous examples of the former class are the metals; the most remarkable of the latter being resins, wax, glass, porcelain, silk, cotton, &c. &c.

Now, if a rod or wire of metal be coated with wax, resin, silk, cotton, or other *insulator*, the electric fluid will pass

freely along the metal, in virtue of its character of a conductor: and its escape from the metal to any lateral object will be prevented by the coating, in virtue of its character of an insulator.

The insulator in such cases is, so far as relates to the electricity, a real tube, inasmuch as the electric fluid passes through the metal included by the coating, in exactly the same manner as water or gas passes through the pipes which conduct it; with this difference, however, that the electric fluid moves along the wire more freely, in an almost infinite proportion, than does either water or gas in the tubes which conduct them.

If, then, a wire, coated with a non-conducting substance, capable of resisting the vicissitudes of weather, were extended between any two distant points, one end of it being attached to one of the extremities of a galvanic battery, a stream of electricity would pass along the wire—*provided the other end of the wire were connected by a conductor with the other extremity of the battery.*

To fulfil this last condition, it was usual, when the electric telegraphs were first erected, to have a second wire extended from the distant point back to the battery in which the electricity was generated. But it was afterwards discovered that the EARTH ITSELF was the best, and by far the cheapest and most convenient, conductor which could be used for this returning stream of electricity. Instead, therefore, of a second wire, the extremity of the first, at the distant point to which the current is sent, is attached to a large metallic plate, measuring five or six square feet, which is buried in the earth. A similar plate, connected with the other extremity of the battery, at the station from which the current is transmitted, is likewise buried in the earth, and it is found that the returning current finds its way back

through the earth from the one buried plate to the other buried plate.

Of all the miracles of science, surely this is the most marvellous. A stream of electric fluid has its source in the cellars of the Central Electric Telegraphic Office, Lothbury, London. It flows under the streets of the great metropolis, and, passing along a zigzag series of railways, reaches Edinburgh, where it dips into the earth, and diffuses itself upon the buried plate. From that it takes flight through the crust of the earth, and *finds its own way* back to the cellars at Lothbury!!

Instead of burying plates of metal, it would be sufficient to connect the wires at each end with the gas or water pipes, which, being conductors, would equally convey the fluid to the earth; and in this case, every telegraphic despatch which flies to Edinburgh along the wires which border the railways, would fly back, rushing to the gas-pipes which illuminate Edinburgh—from them through the crust of the earth to the gas-pipes which illuminate London, and from them home to the batteries in the cellars at Lothbury.

The atmosphere, when dry, is a good non-conductor; but this quality is impaired when it is moist. In ordinary weather, however, the air being a sufficiently good non-conductor, a metallic wire will, without any other insulating envelope except the air itself, conduct the stream of electricity to the necessary distances. It is true that a coated wire, such as we have already described, would be subject to less waste of the electric fluid *en route*; but it is more economical to provide batteries sufficiently powerful to bear this waste, than to cover such extensive lengths of wire with cotton or any other envelope.

The manner in which the conducting wires are carried from station to station is well known. Every railway tra-

veller is familiar with the lines of wire extended along the side of the railways, which, when numerous, have been not unaptly compared to the series of lines on which the notes of music are written, and which are the metallic wires on which invisible messages are flying continually with a speed that surpasses imagination. These wires, in the case of the English telegraphs, are galvanised so as to resist oxydation, and are of sufficient thickness to bear the tension to which they are submitted. They are suspended on posts, erected at intervals of sixty yards, being at the rate of thirty to a mile. These posts, therefore, supply incidentally a convenient means by which a passenger can ascertain the speed of the train in which he travels. If he count the number of telegraph posts which pass his eye in two minutes, that number will express in miles per hour the speed of the train.

To each of these poles are attached as many tubes or rollers of porcelain or glass as there are wires to be supported. Each wire passes through a tube, or is supported on a roller; and the material of the tubes or rollers being among the most perfect of the class of non-conducting substances, the escape of the electricity at the points of contact is impeded.

Notwithstanding these precautions, a considerable escape of electricity still takes place in wet weather. The coat of moisture which collects on the wire, the tube or roller, and the post being a conductor, carries away more or less of the fluid. Consequently, more powerful batteries are necessary to give effect to the telegraph in wet than in dry weather.

In England, and on the Continent, the material used for the supports of the wires is porcelain. In the United States it is glass, which is a more perfect insulator. In England the supports are tubes — on the Continent and in America they are rollers.

In some cases, as for example in the streets of London, it is found inconvenient to carry the wires elevated on posts, as here described. In such cases other methods are adopted.

The wires proceeding from the central telegraph station in London are wrapped with cotton thread, and coated with a mixture of tar, resin, and grease. This coating forms a perfect insulator. Nine of these wires are then packed in a half-inch leaden in-pipe, and four or five such pipes are packed in an iron pipe about three inches in diameter. These iron pipes are then laid under the foot pavements, along the sides of the streets, and are thus conducted to the terminal stations of the various railways, where they are united to the lines of wire supported on posts along the sides of the railways, already described.

Provisions, called *testing posts*, are made at intervals of a quarter of a mile along the streets, by which any failure or accidental irregularity in the buried wires can be ascertained, and the place of such defect always known within a quarter of a mile.

In the Prussian and some other German states, the system of subterranean wires was, until the present time (Dec. 1851), exclusively adopted, not only in cities and towns, but generally along the entire telegraphic lines. Great inconvenience and delay has, however, been found to attend this method. When, from any accidental cause, the buried conductor was interrupted, the place of the defect could be discovered only by disinterring the wire over considerable distances; since it would be impracticable to provide over long telegraphic lines testing posts closely placed. A suspension of the telegraph along entire lines, for several successive days, was therefore frequently the consequence when such accidents occurred. In consequence of this, the system

of subterranean wires is now being superseded by wires suspended on posts, as in England.

In France and in the United States the wires, even in the cities and towns, are conducted on rollers at an elevation, as on other parts of the lines. In Paris, for example, the telegraphic wires proceeding from the several railway stations are carried round the external boulevards and along the quays, the rollers being attached either to posts or to the walls of houses or buildings, and are thus carried to the central station at the Ministry of the Interior.

In Europe, the telegraphic wires invariably follow the course of railways; and this circumstance has led some to conclude that, but for the railways, the electric telegraph would be an unprofitable project.

This, however, is a mistake. In the United States, where a much greater extent of electric telegraph has been erected and brought into operation than in Europe, the wires do not follow the course of the railways. They are conducted, generally, along the sides of the common coach-roads, and sometimes even through tracts of country where no roads have been made.

It is contended in Europe that the wires would not be safe unless placed within the railway fences. The reply to this is, that they are found to be safe in the United States, where there is a much less efficient police, even in the neighbourhood of towns, and in most places no police at all. It may be observed, that the same apprehensions of the destructive propensities of the people have been advanced upon first proposing most of the great improvements which have signalised the present age. Thus, when railways were projected, it was objected that mischievous individuals would be continually tearing up the rails, and throwing obstructions

on the road, which would render travelling so dangerous that the system would become impracticable.

When gas-lighting was proposed, it was objected that evil-disposed persons would be constantly cutting or breaking the pipes, and thus throwing whole towns into darkness.

Experience, nevertheless, has proved these apprehensions groundless; and certainly the result of the operations on the electric telegraph in the United States goes to establish the total inutility of confining the course of the wires to railways. Those who have been practically conversant with the system both in Europe and in America, go further, and even maintain that the telegraph is subject to less inconvenience, that accidental defects are more easily made good, and that an efficient superintendence is more easily insured on common roads, according to the American system, than on railways, according to the European system. Our limits, however, preclude us from entering into all the details of this question.

Nothing in the history of the influence of the arts on social progress presents a more curious subject of reflection than do these systems of metallic wire passing under our feet as we walk the streets, and beside us as we traverse the railways.

"In our metropolis," observes a lively contemporary*, "there is scarcely a street which does not appear to take pride in exposing, as often as possible, to the public view, a series of pipes of all sizes, in which fire of various companies, pure water of various companies, and unmentionable mixtures, common to all, pass cheek by jowl with infinitely less trouble than the motley human currents flow above them. But among all the subterranean pipes laid bare before us,

* "Stokers and Pokers." By the author of "Bubbles from the Brunnens."

there is certainly no one which has more curious contents than the three-inch iron pipe of the Electric Telegraph Company; and yet of all the multitudes who walk the streets, how few of them ever care to reflect what a singular contrast exists between the slow pace at which they themselves are proceeding, and the rate at which, beneath their feet, forty-five electric wires are transmitting in all directions, and to a variety of distances, intelligence of every possible description!

"How singular is it to reflect, that within the narrow space of the three-inch iron pipe which encases them, notice of a murder is flying to the London papers, passing news from India going into the country; along another wire an officer is applying for his regimentals, while others are conducting to and fro the 'price of stocks,' 'news of the Pope,' a speech from Paris of the collapsed poet," &c. &c. &c.

If, from the abrasion of the cotton that surrounds the numerous copper wires within the pipe, any of them come into contact with each other, the intelligence which each is conveying is suddenly confounded; in which case other wires must instantly be substituted. Indeed, even as regards the strong galvanised iron wires which in the open air run parallel to our arterial railways, if in wet weather, in spite of the many ingenious precautions taken, the rain should form a continuous stream between the several wires and the ground, the electric fluid, escaping from the wires, is conducted by the water till it finds earth, the best of all conductors; and the intelligence, instead of going on, say to Edinburgh, follows the axiom of electricity by selecting the shortest road, and thus completing its circuit through the earth, it returns to London. Sometimes, instead of going to earth, it flies back to the office in London, along another wire, to which, by means of a continuous line of water, or of entanglement of the two wires, it has managed to escape;

in which case, the messages on the two wires wrangling with each other, the communication is stopped.

"It is commonly asserted and believed, that many birds are killed by merely perching upon the iron wires of the electric telegraph; but at any time they can do so with perfect impunity. If, indeed, a bird could put one of his feet on the wire, and with the other manage to reach the earth, he would then, no doubt, be severely galvanised. That the railway company's men often pick up under the wires of the electric telegraph, partridges, and other birds, which have evidently been just killed—indeed some are found with their heads cut off—is quite true; but these deaths and decapitations have proceeded, not from the electricity, but from the birds, probably during twilight or a fog, having at full speed flown against the wires, which, of course, cut *their* heads off, just as an iron bar would cut off the head of any man, or alderman on horseback, who at a full gallop was to run foul of it.

"In windy weather, the electric wires form an Æolian harp, which occasionally emits most unearthly music. '*I say, Jack!*' said an engine-driver to his stoker, who like himself was listening for the first time to this querulous sort of noise, proceeding from the newly-erected wires along his line, '*I say, Jack! ain't they a-giving it to them at Threapstone.*'

"When the posts and wires of the electric telegraph between Northampton and Peterborough were being erected, an honest farmer, who for many minutes had been very attentively watching the operation, inquired of the chief superintendent to what use it was to be applied? On being told that by its means he would in a few minutes receive *at Willingborough* a list of the Mark Lane prices *in London*, he evidently incredulously asked how that was to be done?—and on its being explained to him that the intelligence would

be sent down to him *letter by letter*, he exclaimed, '*But you don't mean to say that besides letters it will bring down parcels too?*'" *

But to return to the admirable means whereby those extraordinary effects are produced, and to answer the worthy farmer's inquiry somewhat more intelligibly, let us now see how the electric current which flows along the conducting-wires is made to speak, to make dumb signs, or to write the despatch when it arrives at its destination.

There are a great variety of properties of the electric current which supply means of accomplishing this. If it can be made to affect any object in such a manner as to cause such object to produce any effect sensible to the eye, the ear, or the touch, such effect may be used as a *sign;* and if it be capable of being *varied*, each distinct *variety* of which it is susceptible may be adopted as a *distinct sign*. Such signs may then be taken as signifying the letters of the alphabet, the digits composing numbers, or such single words as are of most frequent occurrence.

The rapidity and precision of the communication will depend on the rate at which such signs can be produced in succession, and on the certainty and accuracy with which their appearance at the place of destination will follow the action of the producing cause at the station from which the despatch is transmitted.

These preliminaries being understood, it remains to show what effects of the electric current are available for this purpose.

These effects are: —

I. The power of the electric current to deflect a magnetic needle from its position of rest.

* "Stokers and Pokers." By the author of "Bubbles from the Brunnens," p. 125—127.

II. The power of the current to impart temporary magnetism to soft iron.

III. The power of the current to decompose certain chemical solutions.

We shall now briefly show the manner in which these properties supply signals sufficiently varied for telegraphic purposes.

1. To explain the deflection of a magnetic needle, let us suppose a copper wire extended over the needle of a common compass, so that the direction of the wire shall be parallel to the needle, without touching it. In this state of things, the needle will remain undisturbed; but if we send an electric current along the wire, which may be done by connecting the ends of the wire with those of a galvanic battery, the needle will instantly throw itself at right angles to the wire, and will remain in that position so long as the galvanic current is maintained; but if that current be discontinued, by withdrawing either end of the wire from the trough, the needle will instantly resume its position of rest.

It is found, also, that the north pole of the needle will turn, in this case, in one direction or in the other, according to the direction given to the galvanic current. If this current flow in one direction, the north pole will throw itself to the east, and the south to the west; if it flow in the contrary direction, the north pole will be thrown to the west, and the south pole to the east.

2. To explain the sudden conversion of iron into a magnet, and the sudden destruction of the magnetic virtue thus imparted, let us suppose a copper wire to be coiled spirally round a piece of soft iron, so that the successive coils shall not touch each other nor touch the iron, which may be done by coating the wire with silk, or any resinous or non-conducting substance. This being done, let us suppose that

an electric current is transmitted through the wire, so that it shall flow spirally round the rod of soft iron, which may be effected by placing, as before, the ends of the wire in a galvanic trough. If steel filings, a needle, or any light piece of iron, be brought near the rod or iron thus circumstanced, they will instantly be attracted by it, showing that it has acquired the magnetic virtue; and this effect will continue to be produced so long as the galvanic current shall be maintained along the spiral wire; but the instant that the end of the wire is withdrawn from the galvanic trough, the magnetic virtue deserts the iron, and it will no longer attract.

3. If a sheet of paper, moistened with a chemical solution which is capable of decomposition by the galvanic current, be laid upon a metallic plate which is in connection with one end of the battery, and the point of a wire in connection with the other end of the battery be brought into contact with the paper, a decomposition will take place, and a change of colour will be produced upon the paper under the point of the wire, just as if a dot were made upon it by a pen charged with coloured ink. If the wire be moved upon the paper, a coloured line will be traced; and if the point of the wire be moved as a pen or pencil might be, any characters may be thus written on the paper as they would be with a pen charged with coloured ink, similarly moved. If in this case the current be discontinued during any intervals, the wire, though still in contact with the paper, will leave no trace or dot.

Let us now see how these three properties have been made instrumental to the transmission of intelligence to a distance.

We have explained how a magnetic needle over which an electric current passes will be deflected to the right or to the left, according to the direction given to the current. Now, it is always easy to give the current the one direction or the

other, or to suspend it altogether, by merely changing the end of the galvanic trough with which the wires are connected, or by breaking the contact.

A person, therefore, in London, having command over the end of a wire which extends to Edinburgh, and is there connected with a magnetic needle, in the manner already described, can deflect that needle to the right or to the left at will.

Thus a single wire and a magnetic needle are capable of making at least two signals.

But signals, whatever be the form of the telegraph used, may be multiplied by repetition and combination. Thus the operator at London may make the needle at Edinburgh move twice successively to the left, and this may be conventionally settled as a sign, independently of that which is produced by a single movement to the left. In like manner, two successive movements to the right will supply another signal; and thus we have four independent signals. But from these four signals we may immediately produce four more, as we may combine one movement to the right with two to the left, and *vice versâ;* and one to the left with two to the right, and *vice versâ:* and thus we should have eight independent signals.

We may carry this method further, and so arrange the system that three successive movements to the right and three successive movements to the left shall have independent significations; and these again may be combined with each of the eight signals already explained; and, in short, we may carry this system to an extent which shall be limited only by the inconvenience of the delay which would take place in making the repetitions necessary for such signals. Subject to this delay, however, it is clear that with a single machine we may easily obtain expressions for all the letters of the alphabet and the ten numerals.

But to obviate the inconvenience which would attend multiplied repetitions in the movements of a single needle, we may provide two independent wires, which shall act upon two independent needles. Each of these needles primarily will afford two independent signals by their movements right and left. These four signals may be combined in pairs, so as to afford four other signals producible by a single movement. Thus, simultaneously with the right-hand movement of one needle we may produce the right-hand movement of the other. In the same way we may simultaneously produce the left-hand movement of both, or the right-hand of either combined with the left-hand movement of the other, which would give eight independent signals, the production of each of which would occupy no more time than that of a single movement. We may then adapt the signals by double movement of each needle, which, combined with each other, and with the single movements, will afford another set of combinations; and by combining these systems, we may obviously obtain all the signals requisite to express the letters and numerals.

Such is, in general, the nature of the signals adopted in the electric telegraphs in ordinary use in England, and in some other parts of Europe.

It may aid the conception of the mode of operation and communication if we assimilate the apparatus to the dial of a clock with its two hands. Let us suppose that a dial, instead of carrying hands, carried two needles, and that their north poles, when quiescent, both pointed to 12 o'clock. When the galvanic current is conducted under either of them, the north pole will turn either to 3 o'clock or to 9 o'clock, according to the direction given to the current.

Now, it is easy to imagine a person in London governing the hands of such a clock erected in Edinburgh, where their

indications might be interpreted according to a way previously agreed upon. Thus, we may suppose that when the needle No. 1. turns to 9., the letter A is expressed; if it turn to 3., the letter B is expressed. If the needle No. 2. turn to 9 o'clock, the letter C is expressed; if it turn to 3. the letter D. If both needles are turned to 9, the letter E is expressed; if both to 3., the letter F. If No. 1. be turned to 9., and No. 2. to 3., the letter G is expressed; if No. 2. be turned to 9., and No. 1. to 3., the letter H, and so forth.

It may be presumed that there can be but little difficulty in conceiving how, by practice, two persons may communicate with each other by such means, almost, if not altogether, as rapidly as they could write and read.

But a difficulty will doubtless suggest itself to the intelligent and inquisitive reader. It will be asked, whether a sentinel must be kept ever on the watch to observe when a message is coming? for as the hands of our clock do not speak, notice could only be received of a coming message by the incessant vigilance of an observer.

Would it not, however, be admirable if we could attach to this clock a striking apparatus, which should address the ear the moment a message is about to be sent, and which should, as it were, awaken the attention of the person on duty?

Such an expedient has, in fact, been contrived. The person in London who desires to communicate a message to the telegraphic agent at Edinburgh, can actually make the clock strike at his will, and thus command attention.

The manner in which this is accomplished is as admirable by its simplicity and efficiency as that which we have just described.

The quality resorted to in this case is the second of those

we have mentioned above, namely, the power to impart the magnetic virtue at will to soft iron.

One of the wires conducted from London passes into the chamber of the telegraphic apparatus at Edinburgh, where it is connected with a coil of wire which envelopes a rod of soft iron. The ends of this rod, which has the form of a horse-shoe, are placed in contiguity, but not in contact, with the detent of a striking apparatus like an alarm-bell. When a message is about to be sent from London, this bell-wire is put in communication with the galvanic trough in London. Immediately the subtle fluid flows along the wire, and converts the horse-shoe rod at Edinburgh into a powerful magnet.

The attractive power which it thus suddenly receives irresistibly draws towards it the detent of the alarum, and lets go the bell, which continues to ring until the agent of the telegraph at Edinburgh answers the demand of the messenger from London, and tells him he is attentive. Then the London communicator withdraws the galvanic current from the bell-wire, the horse-shoe at Edinburgh is instantly deprived of its magnetic virtue, the detent flies back to its place by the action of a spring, and silences the bell.*

In the practical arrangement of electric telegraphs, constructed on this principle, the magnetic needles are placed vertically, and not horizontally as in the mariner's compass, and they are kept, when not affected by the current, in the vertical position, by laying two needles, having their poles at opposite ends, one upon the other, by which means the polarity of the system is neutralised, and then a small excess of weight given to one end of the combined needles

* "Railway Economy," by Dr. Lardner, p. 352—355.

is sufficient to keep them in the vertical position, when fixed upon an horizontal axis. In this manner they are fixed upon the dials already described, being free to turn on their axes when affected by a deflecting force sufficiently strong to overcome the small excess of weight just mentioned.

This is the principle of the telegraph now used generally in England. The entire system, except the lines which follow the course of the South-Eastern Railway, is in the hands of the Electric Telegraph Company, whose central London station is established in Lothbury, near the Bank of England. The lower part of the building is appropriated to the reception of orders and messages. A person desiring to forward a message to any part of England connected with London by the wires, writes his message on a sheet of letter-paper, provided for the purpose, and prepared according to a printed form, having the names and address of the writer, and of the party to whom the message is communicated, in blank spaces assigned to them, together with the date and hour at which the message arrived, and at which the answer was despatched.

It is found that by practice the operators of the telegraphic instruments, constructed on this system, are able to communicate about twenty words per minute, when they work with two needles and two conducting-wires, and at the rate of about eight words per minute when working with a single needle.

Besides the transmission of private despatches, stations have been established in the chief towns of the kingdom, whence and whither intelligence is transmitted from time to time during the day, so that there is thus kept up a never-ceasing interchange of news over the entire extent of that net-work of wires which has overspread the country. At

each of these stations public subscription-rooms have been established, in which are posted from hour to hour as they arrive, during the day, the public news, which are known to be of most interest to the local population, such as the money market, shipping intelligence, sporting intelligence, quotations of the commercial markets at all chief places, and parliamentary and general news.

It will, however, be asked how despatches can be transmitted to various stations along the extensive lines of telegraphic communication which have been established, unless a separate and independent wire be appropriated to each station, which would be manifestly impracticable.

The answer is easy: at each station the conducting wire is carried through the instrument-room of the station, and *passing through the instrument*, is carried out again and continued along the line by the posts as usual. It is therefore apparent, that every message despatched from any station must affect the instruments at *all the other stations;* and if desired, can be interpreted and written out at them all. It is therefore necessary to provide means by which this needless labour shall not be imposed upon the telegraphic agents, and so that it may be at once known for what station or stations each message is intended.

This is accomplished by the following expedient:--The agent at the station from which the message is despatched first sends the current along the *bell-wire.* By the means already described, bells are then rung *at all the stations,* and the attention of the agents is called. The name of the station for which the despatch about to be forwarded is intended, is then transmitted, and appears upon the dials *at all the stations.* The agents at all the stations, except that to which the despatch is addressed, are then released from further attention, and the agent at the station to which it is

addressed interprets the signs as they are successively transmitted, and reduces the message to writing.

It will be seen, therefore, that every message which is despatched, no matter for what station it is intended, is, in fact, sent to all the stations which the wire passes.

The telegraphs established in England, which alone we have here explained, are constructed on the needle system; that is to say, the signals are made by the deviations of magnetic needles from their position of rest, produced by electric currents passing around them.

Telegraphs depending on the second and third principles adverted to above, have been brought into extensive use in America, the needle system being in no case adopted there.

The power of imparting temporary magnetism to soft iron by the electric current has been applied in the construction of telegraphs in a great variety of forms; and indeed it may be stated generally that there is no form of telegraph whatever in which the application of this property can be altogether dispensed with.

To explain the manner in which it is applied, let us suppose the conducting wire at the station of transmission, London for example, to be so arranged that its connection with the voltaic battery may, with facility and promptitude, be established and broken at the will of the agent who transmits the despatch. This may be effected by means of a small lever acting like the key of a pianoforte, which being depressed by the finger, transmits the current. The current may thus be transmitted and suspended in as rapid alternation as the succession of notes produced by the action of the same key of a pianoforte.

At the station to which the despatch is transmitted, Edinburgh for example, the conducting wire is coiled spirally round a piece of soft iron, which has no magnetic attraction

so long as the current does not pass along the wire, but which acquires a powerful magnetic virtue so long as the current passes. So instantaneously does the current act upon the iron, that it may be made alternately to acquire and lose the magnetic property several times in a second.

Now let us suppose this soft iron to be placed under an iron lever, like the key of a pianoforte, so that when the former has acquired the magnetic property, it shall draw this key down as if it were depressed by the finger, and when deprived of the magnetic property, it will cease to attract it, and allow it to recover its position of rest. It is evident in this case that movements would be impressed by the soft iron, rendered magnetic, on the key at Edinburgh simultaneous and exactly identical with the movements impressed by the finger of the agent upon the key in London. In fact, if the key in Edinburgh were the real key of a pianoforte, the agent in London could strike the note and repeat it as often and with such intervals as he might desire.

This lever at Edinburgh, which is worked by the agent in London, may, by a variety of expedients, be made to act upon other moveable mechanism, so as to make visible signals, or to produce sounds, to ring a bell or strike a hammer, or to trace characters on paper by means of a pen or pencil, so as actually to write the message, or to act upon common moveable type so as to print it. In fine, having once the power to produce a certain mechanical effect at a distant station, the expedients are infinitely various, by which such mechanical effect may be made subservient to telegraphic purposes, and, as might be expected, the Crystal Palace abounded with apparatus more or less ingenious and effective founded on these principles.

The telegraph of Morse, extensively used in the United

States, and exhibited by the British Electric Telegraph Company, affords an example of this. To comprehend its mode of operation let us suppose the lever on which the temporary magnet acts to govern the motion of a pencil or style under which a ribbon of paper is moved with a regulated motion by means of clockwork. When the current passes, the style is pressed upon the paper, and when the current is suspended, it is raised from it. If the current be maintained for an interval more or less continued, the style will trace a line on the ribbon, the length of which will be greater or less according to the duration of the current. If the current be maintained only for an instant, the style will merely make a dot upon the ribbon. Lines, therefore, of varying lengths, and dots, separated by blank spaces, will be traced upon the ribbon of paper as it passes under the style, and the relative lengths of these lines, their combinations with each other and with the dots, and the lengths of the blank intervening spaces, are altogether under the control of the agent who transmits the despatch.

It is easy to imagine how a conventional alphabet may be formed by such combinations of lines and dots.

Provisions are made, so that the motion of the paper does not begin until the message is about to be commenced, and ceases when the message is written. This is easily accomplished by the same principle as has been already described in the case of the bell, which gives notice to the attendant in the European telegraph. The cylinders which conduct the band of paper are moved by wheel-work and a weight properly regulated. The motion is imparted by a detent detached by the action of the magnet, which stops the motion when the magnet loses its virtue.

Council medals have been granted to Messrs. Bain and Bakewell, both of whom exhibited electric telegraphs con-

structed upon the third or chemical principle indicated above. As we do not find any essential difference between these instruments, we shall here briefly describe that of Mr. Bain, which is in very extensive operation in the United States.

Let a sheet of writing paper be wetted with a solution of prussiate of potash, to which a little nitric and hydrochloric acid have been added. Let a metallic desk be provided corresponding in magnitude with the sheet of paper, and let this desk be put in communication with a galvanic battery so as to form its negative pole. Let a piece of steel or copper wire forming a pen be put in connection with the same battery so as to form its positive pole. Let the sheet of moistened paper be now laid upon the metallic desk, and let the steel or copper point which forms the positive pole of the battery be brought into contact with it. The galvanic circuit being thus completed, the current will be established, the solution with which the paper is wetted will be decomposed at the point of contact, and a blue or brown spot will appear. If the pen be now moved upon the paper the continuous succession of spots will form a blue or brown line, and the pen being moved in any manner upon the paper, characters may be thus written upon it as it were in blue or brown ink.

An extremely feeble current is sufficient to produce this effect; but it will be necessary, when the strength of the current is very much reduced, to move the pen more slowly, so as to give the time necessary for the weakened current to produce the decomposition. In short, a relation exists between the greatest speed of the pen which is capable of leaving a mark, and the strength of the current; the stronger the current the more rapidly may the pen be moved. In this manner, any kind of writing may be inscribed upon the paper, and there is no other limit to the celerity with which

the characters may be written, save the dexterity of the agent who moves the pen, and the sufficiency of the current to produce the decomposition of the solution in the time which the pen takes to move over a given space of the paper.

The electro-chemical pen, the prepared paper, and the metallic desk being understood, we shall now proceed to explain the manner in which a communication is written at the station where it arrives.

The metallic desk is a circular disk, about twenty inches in diameter. It is fixed on a central axis, with which it is capable of revolving in its own plane. An uniform movement of rotation is imparted to it by means of a small roller, gently pressed against its under surface, and having sufficient adhesion with it to cause the movement of the disk by the revolution of the roller. This roller is itself kept in uniform revolution by means of a train of wheel-work, deriving its motion either from a weight or main spring, and regulated by a governor or fly. The rate at which the disk revolves may be varied at the discretion of the superintendent, by shifting the position of the roller towards the centre; the nearer to the centre the roller is placed, the more rapid will be the motion of rotation. The moistened paper being placed on this disk, we have a circular sheet kept in uniform revolution.

The electro-chemical pen, already described, is placed on this paper at a certain distance from its centre. This pen is supported by a pen-holder, which is attached to a fine screw extending from the centre to the circumference of the desk in the direction of one of its radii.

On this screw is fixed a small roller, which presses on the surface of the desk, and has sufficient adhesion with it to receive from it a motion of revolution. This roller causes the screw to move with a slow motion in a direction from

the centre to the circumference, carrying with it the electro-chemical pen. We have thus two motions, the circular motion carrying the moistened paper which passes under the pen, and the slow rectilinear motion of the pen itself directed from the centre to the circumference. By the combination of these two motions, it is evident that the pen will trace upon the paper a spiral curve, commencing at a certain distance from the centre, and gradually extending towards the circumference. The intervals between the successive coils of this spiral line will be determined by the relative velocities of the circular desk, and of the electro-chemical pen. The relation between these velocities may likewise be so regulated, that the coils of the spiral may be as close together as is consistent with the distinctness of the traces left upon the paper.

Now, let us suppose that the galvanic circuit is completed in the manner customary with the electric telegraph, that is to say, the wire which terminates at the point of the electro-chemical pen is carried from the station of arrival to the station of departure, where it is connected with the galvanic battery, and the returning current is formed in the usual way by the earth itself. When the communication between the wire and the galvanic battery at the station of departure is established, the current will pass through the wire, will be transmitted from the point of the electro-chemical pen to the moistened paper, and will, as already described, make a blue or brown line on this paper. If the current were continuous and uninterrupted, this line would be an unbroken spiral, such as has been already described, but if the current be interrupted at intervals, during each such interval, the pen will cease to decompose the solution, and no mark will be made on the paper. If such interruption be frequent, the spiral, instead of being a continuous line, will be a broken

one, consisting of lines interrupted by blank spaces. If the current be allowed to act only for an instant of time, there will be a blue or brown dot upon the paper; but if it be allowed to continue during a longer interval, there will be a line.

Now, if the intervals of the transmission and suspension of the current be regulated by any agency in operation at the station of departure, lines and dots corresponding precisely to these intervals, will be produced by the electro-chemical pen on the paper, and will be continued regularly along the spiral line already described. It will be evident, without further explanation, that characters may thus be produced on the prepared paper corresponding to those of the telegraphic alphabet already described, and thus the language of the communication will be written in these conventional symbols.

There is no other limit to the celerity with which a message may be thus written, save the sufficiency of the current to effect the decomposition while the pen passes over the paper, and the power of the agency used at the station of departure to produce, in rapid succession, the proper intervals in the transmission and suspension of the current.

But the prominent feature of this system, is the extraordinary celerity of which it is susceptible. The experiment already mentioned, performed by M. Le Verrier and Dr. Lardner before the Committees of the Institute and the Legislative Assembly at Paris, were made with these instruments, and, as we have stated, despatches were sent along a thousand miles of wire, at the rate of nearly 20,000 words an hour.

We shall now explain the means by which this extraordinary feat is accomplished. The despatch must pass through the following preparatory process.

A narrow ribbon of paper is wound on a roller, and placed on an axis on which it is capable of turning so as to be regularly unrolled. This ribbon of paper is passed between rollers under a small punch, which striking upon it makes a small hole at its centre. This punch is worked by a simple mechanism so rapidly, that when it is allowed to operate without interruption on the paper passing before it, the holes it produces are so close together as to leave no unperforated space between them, and thus is produced a continuous perforated line. Means, however, are provided by which the agent who superintends the process, can, by a touch of the finger, suspend the action of the punch on the paper, so as to allow a longer interval to elapse between its successive strokes upon the paper. In this manner a succession of holes are perforated in the ribbon of paper, separated by unperforated spaces. The manipulator, by allowing the action of the punch to continue uninterrupted for two or more successive strokes, can make a linear perforation of greater or less length on the ribbon, and by suspending the action of the punch these linear perforations may be separated by unperforated spaces.

Thus it is evident, that being provided with a preparatory apparatus of this kind, an expert agent will be able to produce on the ribbon of paper as it unrolls, a series of perforated dots and lines, and that these dots and lines may be made to correspond with those of the telegraphic alphabet already described.

Let us imagine, then, the agent at the station of departure preparing to despatch a message. Preparatory to doing so it will be necessary to inscribe it in the perforated telegraphic characters on the ribbon of paper just described.

He places, for this purpose, before him the message in ordinary writing, and he transfers it to the ribbon in per-

forated characters by means of the punching apparatus. By practice he is enabled to execute this in less time than would be requisite for an expert compositor to set it up in common printing type.

The punching apparatus for inscribing in perforated characters the despatches on ribbons of paper is so arranged, that several agents may simultaneously write in this manner different messages, so that the celerity with which the messages are inscribed on the perforated paper may be rendered commensurate with the rapidity of their transmission by merely multiplying the inscribing agents.

Let us now imagine the message thus completely inscribed on the perforated ribbon of paper. This ribbon is again rolled as at first upon a roller, and it is now placed on an axle attached to the machinery of the telegraph.

The extremity of the perforated ribbon at which the message commences is now carried over a metallic roller, which is in connexion with the positive pole of the galvanic battery. It is pressed upon this roller by a small metallic spring, terminating in points like the teeth of a comb, the breadth of which is less than that of the perforations in the paper. This metallic spring is connected with the conducting wire which passes from the station of departure to the stations of arrival. When the metallic spring falls into the perforations of the ribbon of paper as the latter passes over the roller, the galvanic circuit is completed by the metallic contact of the spring with the roller; but when those parts of the ribbon which are not perforated pass between the spring and the roller, the galvanic circuit is broken and the current is interrupted.

A motion of rotation, the speed of which can be regulated at discretion, is imparted to the metallic roller by clock-work or other means, so that the ribbon of paper is made to pass

rapidly between it and the metallic spring, and, as it passes, this metallic spring falls successively into the perforations on the paper. By this means the galvanic circuit is alternately completed and broken, and the current passes during intervals corresponding precisely to the perforations in the paper. In this manner the successive intervals of the transmission of the current are made to correspond precisely with the perforated characters expressive of the message, and the same succession of intervals of transmission and suspension will affect the writing apparatus at the stations of arrival in the manner already described.

Now there is no limit to the speed with which this process can be executed, nor can there be an error, provided only that the characters have been correctly marked on the perforated paper, but this correctness is secured by the ribbon of perforated paper being examined after the perforation is completed and deliberately compared with the written message. Absolute accuracy and unlimited celerity are thus attained at the station of departure. To the celerity with which the despatch can be written at the station of arrival there is no other limit than the time which is necessary for the electric current to produce the decomposition of the chemical solution with which the prepared paper is saturated.

The form of telegraph for which a council medal has been conferred on Mr. Bakewell is, so far as the chemical principle is involved in it, identical with this; but Mr. Bakewell proposes an arrangement by which a message may be transmitted to any distance, by means of telegraphic wire, *in the handwriting of the person who transmits it.* Mr. Bain claims to be the inventor of this part, as well as of the other details, of the apparatus exhibited by Mr. Bakewell, but our limits forbid us from discussing this question.

By this method, to whomsoever the merit of its invention may be due, a person at any station, as for example at London, may write a communication in characters used in common writing or printing on paper placed at another distant station, as for example at Trieste, and this writing shall be traced on the paper with as much precision as if the person writing held the pen in his hand.

We may imagine that the electro-chemical pen placed on the paper at Trieste is extended to London, and there held and directed by the hand of the writer, for this it is which almost literally takes place. The conducting wire, in connection with that part of the electro-chemical pen which is held in the hand, which extends from Trieste to London, may be considered as only forming part of this pen, and the end of such pen at London, held and directed by the hand of the writer, will communicate a motion to its point at Trieste, in exact correspondence with the characters formed by the hand of the writer.

Thus, if the writer at London move the extremity of the conducting wire so as to write a phrase or his usual autograph, the point at Trieste will there inscribe on the prepared paper the same phrase with the same signature annexed, and the writing of the phrase and the signature will be identical with that of the writer.

In the United States, where the electric telegraph has been brought into more extensive and general use than in any other part of the world, and where there are lines whose aggregate length is estimated at nearly 15,000 miles, the needle system adopted exclusively in England is systematically rejected, as being inadequate in its power of transmission to the business of the lines. There are three or four different forms of telegraph adopted by different companies, whose wires, in many instances, run parallel to each

other between the same stations. The systems most generally prevalent are those of Morse and Bain, the former being the magnetic and the other the chemical system explained above. In both the despatches are written in telegraphic characters by the instruments themselves, and may be translated into common language at the bureaux of the telegraph, or delivered as received, at the option of those to whom they are addressed.

In France the magnetic system is adopted, but applied in a manner different from that of Morse. The telegraph being in the hands of the government, and worked by the agents of the old aërial telegraph, it has been found convenient to adopt a system of signs having some analogy to the latter; and, accordingly, the magnets are made to act upon a mechanism by which indices or hands are moved in a manner similar to the motion of the arms of the old telegraph.

In Prussia, and in most of the northern states of Germany, the magnetic principle is also adopted, but differently applied. The system which has been hitherto generally adopted there, is that of Messrs. Siemens and Halske of Berlin, to whom a council medal has been granted. Above 3000 miles of telegraphic lines have been until lately worked in the German states upon this system.

These telegraphs indicate the successive letters of the words, which are read off and written down by the agent at the station. The letters are arranged on keys round a sort of dial. A hand revolves over this dial, pointing to the letters; and the effect of the magnet is such, that the hands upon the dials at the different stations along the line shall move in concert and always point to the same letter.

This system can also be applied so as to print the message

which it despatches at the place of arrival. In this case the indicating wire acts upon a type which it presses upon a strip of paper, leaving its characters printed upon it.

The inventors of this system claim for it several advantages. Mistakes in the despatches transmitted are said to be impossible. The current being always established and broken simultaneously at the two stations of despatch and arrival, currents arising from imperfect insulation of the conducting wire will not influence the harmonious working of the instruments, so long as they are not strong enough to work one or other of the instruments by their own action, and the receiver of the message is always able to interrupt and speak to the communicator.

In fine, therefore, the mode of communicating by these telegraphs may be understood by imagining a circular disc placed at each station, like the dial plate of a watch; but, instead of bearing the indications of the twelve hours, it bears the twenty-four letters of the alphabet. A hand, like the hand of a clock, moves on this dial, and points successively to the letters as it turns. The instruments at the different stations are so constructed and connected that the hands on all of them must always point to the same letter. The agent who sends the despatch, by pressing a key, can cause the hand upon his own dial to point to any letter he may desire, A for example. This will cause the hands of all the dials along the line at the same moment to point to A. In the same manner the successive letters of the words are indicated or printed, according as the indicating or printing telegraph is used.

Since the telegraph has been thrown open to the public, these instruments of Siemens and Halske have been found insufficient for the performance of the business, owing to their slow rate of transmission, and they are now being re-

placed by others constructed on the system of Morse, so extensively used in the United States.

Among the miscellaneous uses to which the electric telegraph is proposed to be applied, the following may be mentioned.

Mr. J. Burdett exhibited a domestic electric telegraph, by which a single bell is made to communicate with any number of rooms. An indicator is attached to the bell, which turns to the number of the room from which the call is made.

Mr. W. Reid also exhibited an electric telegraph adapted for use in private houses, hotels, banks, the offices of public companies, &c.

Mr. Henley exhibited a magneto-electric apparatus for producing the voltaic current for telegraphic purposes, independent of any voltaic battery. The principle of this apparatus, discovered by Faraday, has long been familiar to all scientific men. The apparatus of Mr. Henley, for which he has received the council medal, produces a current having sufficient intensity to evolve the usual electro-chemical phenomena, and all the other effects of a powerful voltaic battery.

Messrs. Jacob and John Brett, of Hanover Square, whose names have lately become so well known to the public in connection with the submarine telegraph, exhibited a printing telegraph on the magnetic principle, for which they have received the council medal, besides a great variety of other interesting and valuable electro-telegraphic apparatus.

By the printing telegraph of Messrs. Brett, an agent at any station, London for example, can instantly, and with unerring precision, transmit and print, in the ordinary letters, a despatch at any distant station, Vienna for example, provided only the two stations are connected by a continuous wire.

This instrument is constructed in various forms to suit the taste of the purchaser. One form, for example, is that of the key-board of a pianoforte. The person who sends a despatch sits down and *plays it*, and it is instantly *printed*, by the movement of the keys, at the place to which it is desired to transmit it.

The printing telegraph is absolutely automatic. It may be erected in an establishment such as the central Post-Office, London, for the reception of correspondence from all parts of Europe, with which London shall be in electrical connection. The despatches arriving during the night, when the offices are closed, and the clerks absent, will be printed by the instruments themselves with unerring correctness. The whole of the communications thus arriving during the night, from the different capitals of Europe, will, on the arrival of the officials in the morning, be found printed.

A person in any capital in Europe can ring a bell in the London Post-Office, to inform the clerks that he desires to send a despatch, and to demand instant attention. To send a despatch, it is only necessary to strike a certain key, by which a current of electricity is sent through the wire to the distant station, where it acts upon the required type, and impresses it on a scroll of paper, which issues, with the despatch printed on it, from an aperture in the instrument. The telegraph is almost independent of superintendence, since the printing ink alone requires renewal, and that not more than about once a month.

A *pocket telegraph* is offered by Messrs. Brett to the guards and others in charge of railway trains, by which they can instantly, at will, communicate, in case of accident, with distant stations.

Electric bells are provided for the Houses of Parliament

by the same ingenious exhibitors, by which the stray members scattered about the legislative palace, in committee-rooms, library, coffee-room, &c. &c., may be summoned to divisions. *A sort of electrical whipper-in!*

The process adopted by Messrs. Brett, for preparing the submarine conducting wires, has been so often described in the public journals, that it can be scarcely necessary here to give any detailed description of it. Four copper wires are carried through the centre of a rope of gutta percha, a certain space, however, being left between them. The gutta percha being a non-conductor of electricity, the current which passes along any one of the four wires cannot escape to the others, or to the sea-water, or other medium in which the rope is immersed. To produce this rope, a mass of gutta percha in a soft state is placed in a cylinder, and by the pressure of a piston is forced through a die of the diameter and form of the rope, along the centre of which the wires are extended. The rope issues from the die, having the wires enclosed within it. It is then passed through a trough of cold water, and rolled upon a drum. This rope is afterwards covered by a coating of strong metallic wire, coiled spirally round it.

It must be observed, that the submarine wires established between Dover and Calais, is not the first instance in which subaqueous conductors for telegraphic communication have been successfully established. The wires of the electric telegraphs in the United States, are laid in several cases at the bottom of extensive rivers and arms of the sea. Between New York and Washington, the wires, protected by a tube or rope of gutta percha, are laid through a distance of four miles at the bottom of an arm of the sea.

It may be, and indeed has been objected, that the vast celerity of transmission conferred upon each conducting wire

by the electro-chemical system of Mr. Bain is superfluous, inasmuch as the number and length of the despatches required to be forwarded, are very far short of any amount which could possibly call such powers into requisition.

The answer to this is obvious. The public has not yet become familiar with the uses of this extraordinary agent of inter-communication. Its extension has, moreover, been restricted hitherto by a tariff so high as to be almost prohibitory. By a most unwise policy, a grant of incorporation was made in 1845 to the Electric Telegraph Company, in virtue of which that body acquired, and until lately continued to possess, a virtual monopoly of the telegraphic communications throughout the country, the only exception being the lines of telegraph following the South Eastern lines of railway, which are possessed and worked by that railway company.

Until within the last year, the general tariff of the Electric Telegraph Company was, for messages not exceeding 20 words, a penny per mile for the first 50 miles, a halfpenny per mile for the next 50 miles, and a farthing per mile for every distance greater than 100 miles, no message being in any case charged less than *2s. 6d.*

These rates were increased one-half for every 10 additional words in the despatch, any fraction of 10 words being counted as ten words.

According to this tariff, the transmission of a despatch consisting of 100 words to a distance of 200 miles, say between London and Liverpool, would cost *42s.*,— a price which, except in cases of the greatest urgency and importance, would constitute a prohibition on the use of the telegraph.

This monopoly has, however, fortunately for the progress of knowledge, been broken up, and, as an inevitable consequence, a material reduction of the tariff has immediately

been made. The Electric Telegraph Company was established with a paid-up capital of 300,000*l.* They became the proprietors, by purchase, of the patent rights of Messrs. Cooke and Wheatstone, in the system of needle telegraph, for which they paid 141,000*l.* A further sum of about 26,000*l.* was applied in the purchase of other inventions. The sum of 104,000*l.* was expended in constructing the conducting wires, and their accessories, and in fitting up the stations, including the direct central station at Lothbury, erected, as is well known, upon a magnificent scale. There are, besides, secondary stations, at which despatches can be transmitted and received at the General Post-Office, Adelaide Street, West Strand, Knightsbridge Terrace, and the several chief railway stations. In spite of the impolitic tariff, by which their business was necessarily restricted, and the large sums paid to patentees, the success of this company has been considerable. Taking an average of three years ending 1851, they are reported to have paid to their shareholders a clear profit of 20 per cent., besides retaining a reserve fund of 60,000*l.* for contingencies.

Their extravagant tariff led to the breaking up of their monopoly by the incorporation of other companies, under the titles of "The British Electric Telegraph Company," the "Magnetic Electric Telegraph Company," and the "Submarine Telegraph Company," the last-mentioned company being that which has laid the conducting wires between Dover and Calais. The formation of these competing companies has been immediately followed by a great reduction of the tariff of the old companies.

This reduced tariff, issued so recently as the 17th November, 1851, establishes the following rates. For every 10 words transmitted to distances not exceeding 100 miles, 1*s.* 3*d.*, over 100 miles, 2*s.* 6*d.*; no charge less than 2*s.* 6*d.*

being made for distances not exceeding 100 miles, and none less than 5*s*. for distances exceeding 100 miles.

Thus the charge for transmitting a despatch of 100 words 200 miles, say between London and Liverpool, is 25*s*.

Notwithstanding the great amount of the tariff even thus reduced, an enormous increase of the business of the company has followed. This company have completed and in operation 2300 miles of telegraphic lines, and about 800 miles in process of construction.

One of the disadvantages to the public which has been ascribed to the monopoly acquired by the Electric Telegraph and South Eastern Companies, is the total exclusion of all improved methods of electric communication, save those particular systems favoured by the directing authorities of these companies. It is even stated that valuable inventions have been purchased by them, not for the purpose of working, but with the intention of smothering them, and that there are some of these which they now decline either to work themselves, or to sell to other companies desirous of working them.

The British Electric Telegraph Company has been established with the avowed object of supplying to the public a cheaper mode of communication, and to bring into use the various inventions of the Messrs. Highton. This company, which obtained its act of incorporation in 1850, after a most severe and protracted opposition on the part of the Electric Telegraph Company, has a capital of 100,000*l*., which they consider sufficient to construct 1000 miles of telegraphic lines, with their accessories. They have now (November, 1851) just commenced their first contract on the Lancashire and Yorkshire Railway.

Neither of the other two companies which have been incorporated has yet commenced the construction of lines in

the interior of the country. One of them, the "Magnetic Telegraph Company," having the small capital of 40,000*l.*, will probably limit their operations to the construction of telegraphs for private and domestic use, such as the connection of houses with offices and external buildings, the connection of different parts of manufactories with the counting-house, &c. The other, the "Submarine" Company, have no line, as yet, in operation, except that between Dover and Calais, from which they take their title. It is understood, however, that they will construct lines from Dover to the interior of the country.

The cost of the construction of the submarine wire rope is said to have been at the rate of 600*l.* per mile, but that a similar rope now in progress of construction will be made for 400*l.* per mile.

Notwithstanding the reduction of the tariff produced by this competition, it is still maintained at an amount which must restrict the use of the electric telegraph to despatches which can be briefly expressed, which have a certain urgency, and which will bear a heavy charge for transmission. But such a reduction of the tariff as would develop all the capabilities of this agent of transmission would, as we conceive, be utterly incompatible with even the most efficient of the telegraphic systems now used in England.

The probable effect of a considerable reduction in the charge for the transmission of telegraphic messages may, in some measure, be estimated from the state of telegraphic business in the United States. There a tariff, considerably lower than that which is established in England, has been adopted; and we find, accordingly, that the amount of the communications is increased in an enormous proportion, and that their character is altogether different. While, for example, no London journal, save *The Times*, has been

hitherto able to afford a daily telegraphic despatch of the French news, exceeding a few lines in length, and that only from Dover to London, the New York journals, and more particularly the *New York Herald*, the price of which is only one penny, while that of the London journals is fivepence, often receive by telegraph complete and detailed reports of the proceedings of Congress at Washington.

During the trial of Professor Webster at Boston, on the charge of murder, which produced so much excitement in the United States and in Europe, a complete report of the examination of witnesses, and the speeches of counsel, was forwarded every night by telegraph from Boston to New York, and appeared in the *New York Herald* the next day.

We have been lately informed, by the proprietors of that journal, that it is intended to publish the debates of Congress, *in extenso*, daily on the morning after they take place at Washington, in the same manner as the London journals publish our parliamentary debates. The debates will be sent *in full* by telegraph to New York, the distance being above 250 miles.

Now, the telegraphic tariff in America, though inferior to that adopted in Europe, is very far above what it might, and no doubt will be reduced to, when the improved and accelerated methods of transmission which we have described, shall be adopted.

By means of two conducting wires it is impossible, with the telegraphs now used in England, to transmit more than 1200 words per hour, and although that average capability be claimed for the existing system, we doubt extremely whether it can be realised one day with another. But assuming it to be practicable, it would follow that in a day of twelve hours, two conducting wires could not transmit more than 14,400 words, which would be equivalent to 144

despatches of the average length of 100 words. Now it is clear that any reduction of the tariff, which would give anything approaching to full play to the demands of the public, once awakened to the advantages which such a system of communication could offer, would create a demand for transmission far exceeding the powers of any practicable number of conducting wires.

But with a system constructed on the principle invented by Mr. Bain, a single wire is capable of transmitting about 20,000 words per hour, and two wires would therefore transmit 40,000 per hour, being thirty-three times more than can now be transmitted.

By the adoption of this system, therefore, the tariff of transmission might, with the same profit, be reduced in a ratio of nearly thirty to one, so that a despatch, the transmission of which would now cost a pound, would be sent at the cost of eight-pence.

But it is evident that in the working out of the system, many other sources of economy would be developed, and a much greater reduction of expenses effected.

When the powers of this improved telegraph shall be brought into full operation, and when this mode of intercommunication shall be available by the public in all parts of Europe, great changes in the social and commercial relations of the centres of commerce and population must be witnessed.

Until a very recent date, the use of the telegraph on the Continent was strictly limited to the government. It is now available by the public almost everywhere, and the entire Continent will soon be covered with a network of telegraphic wires. Wires have just been carried across the Channel, connecting the English with the Continental systems. London therefore, is now, or will very shortly be, connected by continuous lines of telegraphic communication with Brussels,

Berlin, Hamburgh, Lubeck, Bremen, Dantzig, Leipsic, Dresden, Prague, Vienna, Trieste, Munich, Augsburgh, Stuttgard, and the towns along the right bank of the Rhine, from Cologne to Basle; also with Amsterdam, the Hague, Rotterdam, Antwerp, and every part of Belgium; also with Boulogne, Lille, Valenciennes, Paris, Strasburgh, Bourdeaux, Lyons, Marseilles, and all the intermediate towns.

On the arrival of the Indian mail at Marseilles, the leading journals of London, at a cost which would appear fabulous, have obtained their despatches by means of special couriers riding express from Marseilles to Boulogne, and by express steamers from Boulogne to Folkestone. All this will be changed. The agent of *The Times* at Marseilles will receive from the Alexandrian steamer the despatches ready *perforated* on the ribbon of paper (a process which may be executed before their arrival); he will take it to the telegraph office, where it will be attached to the instrument, and will be transmitted direct to London at the rate of 20,000 words per hour on each wire. Two wires will, therefore, transmit three columns of *The Times* in eight minutes!

If a London merchant desire to despatch an important communication to his correspondent at Hamburgh or Berlin, he will be able to do so, and to obtain an answer in five minutes, provided the letter and answer do not exceed a thousand words, and that his correspondent is ready without delay to reply.

If the Foreign Secretary desire to send an important despatch to the British minister at Vienna, he is obliged at present to expedite it by a queen's messenger travelling express. He will then have only to get it perforated on a ribbon of paper in characters known only to himself and the ambassador, and to forward it to Vienna at the rate of 300 words per minute.

These, however, are as yet only *capabilities.* To convert them into *realities* will require more cooperation among the continental states relatively to each other, and to England, and a more perfect organisation of the telegraphic system, than has yet been attained. The force and truth of this observation will be appreciated when we state that, under the system as it is now worked, the transmission of a despatch between London or Paris and Trieste, for example, which might be transmitted in half an hour, often takes *forty-eight hours!*

The causes of this are to be found, to some extent, but not altogether, in the defective organisation of the German lines.

When a despatch requires to be transmitted to a considerable distance, and over several different states, it has to pass through stations where not only different telegraphic alphabets, or systems of signs, are used, but frequently where the telegraphic instruments themselves differ. The despatch in this case has to be transmuted from one system of telegraphic language into another, which is always attended with delay and a liability to error of interpretation and transcription.

It is evidently impracticable to communicate despatches telegraphically between two stations, unless they possess the same telegraphic instruments and the same system of signs.

Every station, therefore, which stands between two different systems, must necessarily be supplied with the instruments and interpreters of both. Thus, in England, the system known as the double-needle system prevails. In France, as has been stated, a magnetic system, having an analogy to the old aërial telegraph, is exclusively adopted. In at least part of Belgium, the double-needle system, we believe, prevails. In Prussia, to some extent, the system of Siemens is adopted, either for indicating or printing, or

both; but this is already partially superseded, as has been already stated, by the system of Morse.

In a word, a great variety of different telegraphic instruments and different corps of employés, are scattered over the vast network of telegraphic communications which cover a large part of the Continent; and difficulty, delay, and multiplied liabilities of error arise in the transmission of despatches from one system to another. All this can be readily conceived.

To realise in practice all that the electric telegraph is capable of, and transmit instantly a despatch from London or Paris to Trieste, for example, it would be necessary, first, to have a continuous wire between the two places; secondly, to have the same system of telegraphic instruments established at the two stations; and, thirdly, to adopt the same telegraphic alphabet. Under such conditions, and such only, would it be practicable to transmit a despatch without delay between two such distant stations.

The following tables, showing the telegraphic tariffs in England, France, and the other Continental states over which telegraphic wires have been carried, will supply some estimate of the cost of transmitting despatches between different stations in Europe.

British Tariffs. — *Electric Telegraph Company.* — For despatches not exceeding 20 words, to distances not exceeding 100 miles, *2s. 6d.*; to all greater distances, *5s.* An addition of one-half of these rates is made for each ten words, or fraction of ten words additional, or a charge of *3d.* per word, at the option of the party sending the despatch.

Telegraphic messages are despatched by messengers immediately on their arrival at the stations, and are delivered in carefully-closed envelopes, at a charge of *6d.* for the first half mile, and *6d.* per mile additional, if on foot; and if sent

out by express messengers by fly, cab, horse, or rail, at a charge of 1*s.* for the first half mile, and 1*s.* per mile additional.

South Eastern Company. — The charge for the transmission of telegraphic messages to or from any station on the South Eastern Railway and its branches, is now 5*s.* for twenty words or under, and 3*d.* for every additional word.

A message and answer are considered as one communication, and are charged according to the total number of words.

Cipher communications are sent according to the same rates, four cipher or private signals being considered equivalent to twenty words.

Messengers are despatched with telegraphic communications immediately on their arrival, and are charged at the rate of 8*d.* per mile, 1*s.* being the minimum charge. The messenger is invariably sent by cab, in London, when medical men are required, unless otherwise ordered. Cab fare is charged in addition.

Submarine Telegraph Company.—For a despatch of twenty words between Dover and Calais, 10*s.*

FRENCH TARIFF.

TABLE showing the Electric Telegraphic Stations in France, and the Cost of Transmission of Despatches from Paris to the several Stations.

	Distance.	For Twenty Words.	For every Ten additional Words.	Per Mile for Twenty Words.
	Miles.	s.	d.	d.
Amiens - - -	91	3·8	11·4	0·50
Angers - - -	216	5·7	17·1	0·32
Arras - - -	131	4·5	13·4	0·41
Blois - - -	113	4·2	12·5	0·45
Bourges - - -	146	4·7	14·0	0·39
Calais - - -	234	6·0	18·0	0·31
Chalons-sur-Marne -	107	4·1	12·2	0·46
Chalons-sur-Saone -	238	5·6	18·3	0·28
Châteauroux - -	164	4·9	14·8	0·36
Dunkirk - -	221	5·8	17·4	0·31
Havre - - -	142	4·6	13·7	0·39
Lille - - -	170	5·1	15·1	0·36
Nantes - - -	269	6·6	19·7	0·30
Nevers - - -	188	5·4	16·0	0·35
Orleans - - -	76	3·6	10·8	0·57
Poitiers - - -	210	5·6	16·8	0·32
Rouen - - -	87	3·7	11·1	0·51
Tonnerre - -	122	4·3	12·8	0·42
Tours - - -	147	4·7	14·0	0·39
Valenciennes - -	172	5·1	15·1	0·36
Belgian frontier - -	179	5·2	15·4	0·35

GERMAN AND BELGIAN TARIFF.

TABLE showing the Electric Telegraphic Stations of the several Lines in operation on the Continent (excepting France), the average relative Distances of the Stations, and the Cost of Transmission to the Stations respectively from Calais.

	Approximate Average Distance from Calais.	For Twenty Words.	Cost per Mile.
	Miles.	s.	d.
Brussels, Malines, Antwerp, Liege, Ghent, Bruges - - -	176	8·0	0·55
Mons - - - -	127	6·0	0·56
Verviers, Ostend - - -	280	10·0	0·50
Aix-la-Chapelle - - -	269	12·0	0·53
Cologne, Deutz, Elberfeld, Dusseldorf -	387	14·0	0·50
Munster, Hamm - - -	412	16·0	0·46
Minden, Hanover, Brunswick -	511	18·0	0·42
Oschersleben, Magdeburgh, Potsdam, Berlin - - - -	648	20·0	0·37
Wittenburg, Hagenau, Stettin, Franckfort-on-Oder, Interbog, Dessau, Cothen, Halle, Leipsic - -	767	22·0	0·34
Weimar, Erfurt, Gotha, Eisenach, Cassel, Dresden, Hof, Bamburg, Hamburgh, Cosel, Liegnitz, Breslau, Oppeln, Ratibor, Oderberg, Prague, Aussig, Bodenbach - -	870	24·0	0·33
Marburg, Giessen, Frankfort-on-Maine, Wursburg, Aschaffenburg, Nuremberg, Augsburgh, Brünn, Munich (by Hof), Ollmutz, Vienna, Cracow -	1100	26·0	0·29
Salzburg (by Hof), Presburg, Pesth, Gratz, Liaz, Salzburg (by Oderberg)	1200	28·0	0·28
Agram, Laibach, Trieste, Venice, Verona, Milan, Munich (by Vienna), Inspruck, Bregeaz, Bozen - -	1600	30·0	0·22

AMERICAN TARIFF.

TABLE showing the Cost of Transmission of Despatches on some of the principal Electro-Telegraphic Lines of the United States (1850).

	Distance.	For Twenty Words.	For each additional Word.	Per Mile for Twenty Words.
From Washington to	Miles.	d.	d.	d.
Baltimore - -	40	10	0·5	0·25
Philadelphia - -	156	30	1·5	0·19
Trenton (New Jersey)	184	45	2·0	0·24
Princeton „ -	194	50	2·5	0·25
New York - -	243	50	2·5	0·20
Alexandria (Virginia) -	10	16	0·5	1·60
Fredericksburg „ -	60	21	0·5	0·35
Richmond „ -	121	27	0·5	0·22
Petersburg „ -	143	29	0·5	0·20
Raleigh (N. Car.) -	292	44	1·0	0·15
Fayetteville „ -	349	50	1·5	0·14
Cheraw (S. Car.) -	419	57	1·5	0·14
Camden „ - -	476	63	1·5	0·15
Columbia „ - -	509	66	1·5	0·13
Charleston „ - -	644	79	2·0	0·12
Augusta (Georgia) -	782	93	2·5	0·12
Savannah „ -	914	106	2·5	0·116
Macon „ -	1107	126	3·0	0·113
Columbus „ -	1200	135	3·5	0·112
Montgomery (Alabama)	1299	145	3·5	0·111
Cahisoba „ -	1351	150	4·0	0·110
Mobile „ -	1523	167	4·0	0·110
New Orleans „ -	1716	200	5·0	0·115

The preceding table, showing the tariff of the telegraphs in the United States, has been calculated from the most recent information accessible to us. The progress of affairs is, however, so rapid in that country, that it is probable that since the dates of our information, modifications have been made in the tariffs; and, if so, it may be regarded as certain that such modifications, being those produced by the competition of rival companies, have had the effect of reducing rather than augmenting the rates of charge.

It may therefore be safely assumed that, in the United States, the charge per mile, for a despatch not exceeding twenty words, for the lesser class of distances, does not exceed a farthing per mile, while for the greater distances it does not amount to more than half that rate.

From a comparison of the preceding tables, therefore, we deduce the following:

TABLE showing the comparative Cost of transmitting a Despatch of Twenty Words by Electric Telegraph in England, France, the German States, and the United States.

	England.	France.	German States.	United States.
Not exceeding 100 miles -	2*s.* 6*d.*	3*s.* to 4*s.*	5*s.*	10*d.* to 2*s.*
From 100 to 200 miles -	5*s.* 0*d.*	4*s.* to 5*s.* 6*d.*	8*s.*	2*s.* to 4*s.*
From 200 to 400 miles -	5*s.* 0*d.*	5*s.* 6*d.* to 8*s.* 6*d.*	8*s.* to 16*s.*	4*s.* to 5*s.*
From 400 to 800 miles -	- -	8*s.* 6*d.* to 17*s.*	16*s.* to 22*s.*	5*s.* to 8*s.*
From 800 to 1200 miles -	- -	- -	22*s.* to 28*s.*	8*s.* to 11*s.*
From 1200 to 1800 miles -	- -	- -	28*s.* to 32*s.*	11*s.* to 16*s.*

Thus it appears that the rates for distances under 100 miles, in the United States, are less than one-fourth of the German, and one-half of the English tariff, and for greater distances they are less in a still higher ratio than the European tariffs.

This will explain, in a sufficiently satisfactory manner, the more extensive amount of business done by the American telegraphs. But even in the United States, low, comparatively with the European lines, as the tariffs are, they are not yet brought down to that point at which the public would be enabled to derive from this vast agent of

inter-communication all the benefits which it is capable of affording. The systems of transmission adopted in the United States, though more efficient than those which have obtained preference in Europe, are still feeble in their transmitting power, compared with those of which the electric agency is susceptible; and we are sanguine enough, encouraged by the miracles which we have already witnessed, and by the results of the experiments which have been explained, to look forward to an epoch, not very remote, at which the electric telegraph will prove itself to be to the post-office what the power has been to the hand-loom, the lace-frame to the cushion, the stocking-loom to the knitting-needle, the mule to the distaff, the locomotive to the horse, and the press to the pen.

A project has been announced in the journals, which might be justly regarded as the creature of some candidate for Bedlam, if, after what we have stated as being actually practised, we could dare to pronounce anything of the kind impracticable. The project we allude to is, to carry a telegraphic communication across the Atlantic! It is proposed to encase a number of wires in a coating which will not be affected by sea-water, and to sink it in the ocean! One extremity of this *electric cable* is to be fixed at New York or Boston, and the other, we presume, at Galway!

It is curious to observe how often that which is regarded as fantastical and chimerical in one age, acquires the character of cold reality in another.

"Strada, in one of his prolusions," says Addison, "gives an account of a chimerical correspondence between two friends by the help of a certain loadstone, which had such a virtue in it, that if touched by two several needles, when one of these needles so touched began to move, the other, though at ever so great a distance, moved at the

same time and in the same manner. He tells us that two friends, being each of them possessed of these needles, made a kind of dial-plate, inscribing it with twenty-four letters, in the same manner as the hours of the day are marked upon the ordinary dial-plate. They then fixed one of the needles on each of these plates in such a manner that it could move round without impediment, so as to point to any of the twenty-four letters. Upon their separating from one another into distant countries, they agreed to withdraw themselves punctually into their closets at a certain hour of the day, and to converse with one another by this their invention. Accordingly, when they were some hundred miles asunder, each of them shut himself up in his closet at the time appointed, and immediately cast his eye upon the dial-plate. If he had a mind to write anything to his friend, he directed his needle to every letter that formed the words that he had occasion for, making a little pause at the end of every word or sentence, to avoid confusion. The friend, in the meanwhile, saw his own sympathetic needle moving of itself to every letter which that of his correspondent pointed at. By this means they talked together across a whole continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas or deserts.

"If M. Scudery, or any other writer of romance," continues Addison, "had introduced a necromancer, who is generally in the train of a knight-errant, making a present to two lovers of a couple of those above-mentioned needles, the reader would not have been a little pleased to have seen them corresponding with one another when they were guarded by spies and watches, or separated by castles and adventures.

"In the meanwhile, *if ever this invention should be revived or put in practice*, I would propose that on the lover's dial-plate there should be written, not only the twenty-four let-

ters, but several entire words, which have always a place in passionate epistles: as flames, darts, die, language, absence, Cupid, heart, eyes, hang, drown, and the like. This would very much abridge the lover's pains in this way of writing a letter, as it would enable him to express the most useful and significant words with a single turn of the needle."

Addison wrote this in 1711. Had he lived a hundred and forty years later he would have seen not only the sympathetic needles of Strada, but even the alphabetic dial literally realised. The form of magnetic telegraph invented by M. Siemens, and constructed and in operation on some of the Prussian lines, presents the precise form described by Strada. The needles established at two distant stations play upon two dials, on which, instead of the twelve hours, are engraved the twenty-four letters, and the electric current and the mechanism connected with it cause the needles to move *sympathetically*. Whatever letter one is made to point at, the other instantly turns to the same, even though they should be separated by " cities or mountains, seas or deserts."

But he might witness still greater miracles. A lover in London might write an epistle to his mistress in Vienna, the handle of the pen being in London, and its point and the sheet of paper on which the letter is written being in Vienna!

Our limits warn us that notwithstanding the fascination of its subject, and the boundless fertility of its theme, this essay must come to a close. We must leave to others to pursue, into their more remote and perhaps even more important consequences, those immortal discoveries, those victories of mind over matter, whose unfading splendour will render our age for ever memorable.

The author of some of the most popular fictions of the day has affirmed, that in adapting to his purpose the results of his personal observation on men and manners, he had found himself compelled to mitigate the real in order to bring it within the limits of the probable. No attentive and contemplative observer of the progress of the arts of life, at the present time, can fail to be struck with the prevalence of the same character in their results as that which compelled the writer alluded to to suppress the most wonderful of what had fallen under his eye, in order to bring his descriptions within the bounds of credibility.

Many are old enough to remember the time when persons, correspondence, and merchandise were transported from place to place in this country by stage-coaches, vans, and waggons. In those days the fast-coach, with its team of spanking blood-horses, and its bluff driver, with broad-brimmed hat and drab box-coat, from which a dozen capes were pendant, who "*handled the ribbons*" with such consummate art, could pick a fly from the ear of the off-leader, and turn into the gateway of Charing Cross with the precision of a geometrician, were the topics of the unbounded admiration of the traveller. Certain coaches obtained a special celebrity and favour with the public. We cannot forget how the eye of the traveller glistened when he mentioned the Brighton "Age," the Glasgow "Mail," the Shrewsbury "Wonder," or the Exeter "Defiance," — the "Age," which made its trip in five hours, and the "Defiance," which acquired its fame by completing the journey between London and Exeter in less than thirty hours.

The rapid circulation of intelligence was also the boast of those times. With what pride was it not announced that the news of each afternoon formed a topic of conversation at tea-tables the same evening, twenty miles from London, and

that the morning journals, still damp from the press, were served at breakfast within a radius of thirty miles, as early as the frequenters of the London clubs received them.

Now let us imagine that some profound thinker, deeply versed in the resources of science and art at that epoch, were to have gravely and publicly predicted that the generation existing then and there would live to see all these admirable performances become obsolete, and consigned to the history of the past; that they would live to regard such vehicles as the *Age* and *Defiance* the clumsy expedients of past times, and their celerity such as to satisfy those alone who were in a backward state of civilisation!

Let us imagine that such a person were to affirm that his contemporaries would live to see a coach like the Exeter *Defiance* making its trip, not in thirty, but in five hours, and drawn, not by 200 blood-horses, but by a moderate-sized stove and four bushels of coals!

Let us further imagine the same sagacious individual to declare that his contemporaries would live to see a building erected in the centre of London, in the cellars of which machinery would be provided for the fabrication of *artificial lightning*, which should be supplied *to order*, at a *fixed price*, in any quantity required, and of *any prescribed force*; that *conductors* would be carried from this building to all parts of the country, by which such *lightning* should be sent at will; that in the attics of this same building would be provided certain small instruments like barrel-organs or pianofortes, played on by boys; that by means of these instruments, the aforesaid lightning should, at the will and pleasure of the said boys, deliver messages at any part of Europe, from Petersburgh to Naples; and, in fine, that answers to such messages should be received instantaneously, and by like means: that in this same building offices should be pro-

vided, where any lady or gentleman might enter, at any hour, and for a few shillings send a message by *lightning* to Paris or Vienna, and by waiting for a few moments, receive an answer!

Suppose that his foresight extending still further, should lead him to declare, that individuals in any one city or town in Europe, would be enabled to write a document, sign their name, or make a design or drawing on paper, placed in any other town, however distant, and that the characters and traces made by their pen or pencil, should be produced as exactly, and as promptly, as if the paper were upon the desk before them; that an individual holding a match in Petersburgh, should be enabled to fire a cannon at Naples; that the light of the sun, without other aid or guidance, should be able to make a portrait of a person, or a picture of natural objects or scenery, with a fidelity, truth, and precision, with which the productions of the most exalted artistic skill would not bear comparison; and that this picture should be produced and completed in its most minute details in a few seconds,—nay, even in the fraction of a second; that candles and lamps would be superseded by flame, manufactured on a large scale in the suburbs of cities, and distributed for use in pipes, carried under the streets, and into the houses and other buildings to be illuminated; and that the precious and other metals used for ornament and use, being dissolved in liquids, would form themselves into the articles of ornament and use by a spontaneous process, and without the intervention of human labour or skill.

No authority however exalted, no attainments however profound, no reputation however respected, could have saved the individual rash enough to have given utterance to such predictions some twenty years ago, from being regarded as

labouring under intellectual derangement. Yet all these things have not only come to pass, but the contemplation of many of them has become so interwoven with our habits, that familiarity has blunted the edge of wonder.

Compared with all such realities, the illusions of Oriental romance grow pale; fact stands higher than fiction in the scale of the marvellous; the feats of Aladdin are tame and dull; and the slaves of the lamp yield precedence to the spirits which preside over the battery and the boiler.

II.

THE POTTER'S ART.

No department of the great museum of industrial products presented to the attention of the intelligent visitor attraction stronger and more peculiar than that which was devoted to the ceramic manufactures, including porcelain in all its varieties, Oriental and European, earthenware, stoneware, flintware, faience, delft, ironstoneware, terra-cotta, bricks, tiles, and in general every form of baked earth used in the arts and sciences.

In no branch of the useful arts do the ultimate results differ so immeasurably from the original materials as in this. What can more powerfully excite our wonder and admiration at the value which labour and art can confer on the basest materials than to reflect that the beautiful portraits in Sèvres porcelain of the Queen and Prince Albert, after Winterhalter, and the magnificent vases which were seen both in the British and foreign collections, are composed of nothing more than so many lumps of a whitish clay, and a collection of the rusts (oxides) of certain metals, all beyond this being the work of art?

Another circumstance which conferred peculiar interest on this section of the Exhibition is the extraordinary rivalry which it developed among different countries, and the unequal conditions under which British industry entered into this

competition. Seven imperial and royal establishments for the manufacture of porcelain, supported by State subsidies, and encouraged by State patronage, sent their choicest productions to be displayed beside those of the unpatronised, unsubsidised enterprise, of Staffordshire and Worcestershire. Thus we had in the French department a magnificent collection of the finest pieces of porcelain from the National (late Royal) manufactory of Sèvres. A similar collection was sent from the celebrated Royal porcelain works of Meissen, near Dresden. The Royal porcelain manufactory of Berlin, and the Imperial porcelain manufactory of Vienna, each sent a rich collection of its respective productions. Besides these, the Royal manufactories of porcelain of Copenhagen and Nymphenburg, near Munich, and, in fine, the Imperial porcelain works of St. Petersburgh, severally unfurnished their museums and transferred their richest treasures to the Crystal Palace.

The fabrication of ornamental porcelain in these several national establishments, is conducted irrespectively of commercial profit. If any expedient for the improvement of the art be proposed to a British manufacturer, he must necessarily consider the probable cost of trying it, and the probable loss in the event of its failure. These considerations are, however, disregarded in establishments supported by the State, and every expedient for the improvement of the art, presenting the slightest probability of a successful result, is tried. All that is most eminent in science, in each of the countries above-mentioned, is brought to bear upon the improvement of the ceramic art. Besides pecuniary emolument, personal honours and rewards are lavished on all who contribute to its advancement. Thus, we find at the head of each of these establishments, as well as at the head of each of their departments respectively, individuals who have attained the greatest eminence in those sciences which are

more immediately connected with this branch of manufacture, and personal honours and distinctions, such as orders of knighthood, decorations, crosses, &c., lavished upon them, as a further stimulus to exertion.

The antiquity of the ceramic art renders it an object of especial interest. Every one is familiar with the allusions to the potter's wheel in the Old Testament; and indications of the prevalence of the manufacture at an early epoch in the history of the human race, are abundantly confirmed by the annals of oriental nations, and by the material evidence of vases of baked earth which have been found in ancient tombs, and which are preserved in the national collections.

Among the objects exhibited in the Chinese department, was included a complete collection of the various materials employed at the great porcelain works of Kiang Tiht' Chin, as it is named in the Catalogue, otherwise, according to better authorities, King Te Tching. This collection consisted of specimens of the plastic clay, of which the Chinese porcelain is formed, and of the various colouring matters with which it is decorated.

The place from which these specimens were sent is the seat of a very ancient manufactory of porcelain. Father Entrecolles, a French missionary, resided there in the beginning of the last century, and he states in his letters (published in Paris in 1741) that there were in operation at this place, in 1712, not less than 3000 ovens, which gave the town, during the night, the aspect of a vast furnace with a multitude of chimneys. It is impossible, in reading his description, not to be reminded of the appearance of certain parts of Staffordshire at night. During the residence of this missionary, ancient pottery was in great demand, and bore extraordinary prices in China. The vessels obtained in tombs and other ruins bore marks of high antiquity. Thus it is

related that vases were found which bore evidence of having belonged to the Emperors Yao and Chun, who reigned 2357 B.C., and 2255 B. C. In further corroboration of this, examples are produced of vases of Chinese origin found in ancient tombs at Thebes, which appear by their inscriptions to have been fabricated eighteen centuries before the Christian era. Several such vessels have been found. Mr. Wilkinson brought two to England, one of which is in the British Museum, and another is in the museum at Alnwick. It was not, however, until a comparatively recent date that the fine porcelain, afterwards so celebrated and so much esteemed in Europe, was fabricated in China. It was only under the dynasty of Song, from 960 to 1278 A. D., that porcelain began to be manufactured of fine materials, and to acquire that degree of perfection which has since been so much admired.

The fine porcelain of China was first imported into Europe by the Portuguese in 1518, and for 200 years after that time Europe continued to derive its entire supply of that article of luxury from China. This fact is the more remarkable when it is considered, as will presently appear, that the material for the fabrication of porcelain existed in unbounded quantity, and of the finest quality, in almost every country of Europe. The merit of the discovery of the materials and the art of fabricating fine porcelain in Europe is due to Saxony, and the first manufactory at which this article was fabricated was that which has since been so celebrated as the Royal manufactory of Meissen. The history of the origin and progress of this manufactory is curious, but, before relating it, it will be necessary to explain some circumstances connected with the process of manufacture of pottery in general.

All pottery is formed of plastic clay, which, being shaped into the vessels desired to be produced, is hardened by baking, and rendered impervious to water by being covered with a glaze, which also resists acids and other chemical

agents to which it may be exposed. The clay possessing the necessary qualities being mixed with a certain quantity of water, and well kneaded, is reduced to a mass resembling common dough. The desired form is given to it either by turning, moulding, or casting. The instrument by which it is turned, called the potter's lathe or wheel, consists of a small circular stage placed horizontally, and supported on a vertical shaft, to which rotation is imparted. When the doughy mass is placed upon this stage, and put into rapid revolution, the hand of the potter is applied to it, and it undergoes an operation resembling that of turning in the common lathe. In this manner all circular forms are produced. Vessels, and the parts of vessels, which are not circular, such as the handles, spouts, feet, &c., are produced by moulding or casting, and are afterwards attached to the vessels which have been formed upon the lathe, as already described. The surface of the vessels thus formed after coming from the oven is rough, and the texture of the material more or less porous, so that it would imbibe any liquid which might be poured into it. To prevent this, and to give greater beauty and durability to the article, it is dipped into a liquid of creamy consistency, which holds in suspension some substance capable of vitrifaction. After immersion, a coating of this liquid adheres to the surface. The water which holds the vitrifiable substance in suspension is partly imbibed by the material of the vessel. The vessel, thus coated, is placed in an oven, and again exposed to the action of heat of sufficient intensity to vitrify the coating with which it is invested, so that, when withdrawn from the oven, the coating is converted into a true glass, and the vessel is said to be glazed. In the coarser sorts of pottery, the material of which is red or brown clay, the glaze is coloured and opaque, so that the vessel coated with it takes

the colour of the glaze, the clay composing it being concealed. In the finer earthenware, the material of which is white clay, the glaze is generally colourless and perfectly transparent, so that, after vitrification, the surface of the earthenware is seen through it, the glaze being, in fact, nothing more than a coating of transparent and colourless glass. Sometimes a pattern in colours is made upon the surface of the article before the glaze is produced upon it: in such case the pattern is seen through the glaze, and is preserved by it. In other cases, however, the ornamentation is made after and upon the glaze. The colouring materials with which the ornamentation is produced, are metallic oxides. When the pattern or design has been drawn upon the surface, the article is again submitted to the agency of fire, by which the colours which have been laid upon it are not only vitrified, but changed in their tints. It is therefore necessary that the manufacturer should have the skill to foresee the effect of fire upon his colouring materials. In this he often errs, and is therefore obliged to retouch his work, and submit it a second time to the oven before it can be regarded as finished.

The first attempts made in Europe to fabricate a hard earthenware covered with a coloured glaze are ascribed to the Moors of the Spanish Peninsula in the ninth century. After this the manufacture was established in the island of Majorca, where it was carried on upon a considerable scale. In the fourteenth century a manufactory of earthenware, which afterwards obtained considerable celebrity, was erected at Faenza, in the States of the Church, where a commerce in stoneware was carried on upon a considerable scale, and from which that description of ware came to be known in France and on the Continent by the name of "Faience." This ware was, however, made of a red clay, and was necessarily coated with a coloured and opaque glaze. After some time it was imitated

with considerable success, and was much improved both in France and Holland. A manufactory was established by the celebrated Bernard de Palissy, at Saintes, in France, and another, on a not less considerable scale, at Delft, in Holland. From this latter place, large exportations of this ware were made to England, whence it came to be called in this country "Delft."

During this period considerable improvement was made in its manufacture, a white plastic clay being discovered and substituted for the red clay of Faenza, and a transparent colourless glaze for the opaque and coloured coating already mentioned. About the middle of the seventeenth century, a small factory for the manufactory of pottery was established at Burslem, in Staffordshire. In the year 1690, the manufacture carried on at this place was considerably improved by the Messrs. Elers, who had immigrated there from Holland, bringing with them the knowledge, skill, and experience of that seat of the art. There were at this time about twenty-two ovens at Burslem.

The Messrs. Elers had not long been there before they discovered in the neighbourhood a bed of clay of very superior quality, and, erecting upon the spot itself a factory, resorted to extraordinary and curious measures to keep in profound secrecy their materials and their processes. With this view they not only excluded most rigorously from their works all visitors whatever, but selected for their operatives the most stupid and ignorant persons they could find, and so divided the labour that no one individual possessed more knowledge than that of the very process at which he was employed. These precautions were, however, of little avail. The stimulus of profit and the spirit of enterprise are not to be repressed by such shallow expedients. A workman named Twyford imposed upon them by affecting indifference to the

art, and managed to get admitted to their employment. He soon ascertained some of their secrets, but it remained for another more astute and persevering person to discover all the details of their processes. An individual named Astbury, appreciating the importance of the manufacture, and foreseeing the profits likely to arise from it, decided on adopting a course and persevering in it, which, as he imagined, and as proved by the event, would lead to a complete discovery. He affected the manners of an idiot, deceived them, and got into their employment, and was adroit enough to sustain the deception for several years, until he became complete master of their secrets. After this, the Messrs. Elers left Staffordshire in apparent disgust, and settled in London, where, at a later period, they were probably instrumental in establishing the well-known porcelain works at Chelsea.

This was the origin of the celebrated Staffordshire Potteries, now a hive of industry, covering an area eight miles in length and six in width, and employing 70,000 operatives, a large proportion of whom belong to the class of skilled labour, and no inconsiderable part to the highest order of art. It is here we may find the splendid establishments of Messrs. Copeland, Minton, Wedgwood, Alcock, Pratt, Mayer, Boote, Mason, and others, whose productions enriched the gallery of the northern transept of the Exhibition.

One of the ingredients of fine pottery is silica, or the earth of flints. The circumstance which led to the application of this substance to the art is thus related: — Mr. Astbury, the son and successor of him who gained the knowledge of Elers's secret by feigning idiocy, being on his road to London, and making the journey on horseback, was stopped at Dunstable in consequence of his horse being attacked with a malady of the eyes. The innkeeper at whose house he put up advised him to apply a poultice of calcined flints. Astbury observed that the flints, which before calcination were black, were by

this process converted into a white substance. It occurred to him that he might bleach the clay of his pottery by mixing it with the substance, which thus became white in the fire. He accordingly realised this with complete success, and afterwards silica became a regular ingredient of pottery.

Notwithstanding the progress thus made between the ninth and the sixteenth century in the manufacture of pottery throughout Europe, China still continued to be the exclusive source from which the finer sort of earthenware came, so that this ware acquired, and still retains in England, the name of "china," being distinguished, however, on the Continent, from the inferior sorts of earthenware by the denomination of "porcelain." The origin of this term "porcelain" is uncertain, but is supposed to proceed from the Portuguese word *porcellana*, signifying a drinking-cup.

After what has been related above of the efforts made in every part of Europe to improve the manufacture of pottery, and from the high estimation in which the porcelain of China and Japan was everywhere held, and the high prices at which it was generally purchased, it may well be supposed that extraordinary means were resorted to by private industry, and extraordinary inducements offered by the sovereigns of Europe, in the shape of rewards and honours, for the discovery of the means of fabricating these precious wares. The processes of turning, moulding, and casting, of baking and glazing, being all known, the great desideratum which remained was the clay, now called china clay, which, up to the time we now refer to, had never been found in any part of Europe, although, as will presently appear, it could be obtained everywhere. This clay, which in China is called "kaolin," a name which has been adopted also in Europe, consists of silica and alumina in variable proportions. When exposed for a short time to a certain temperature, it undergoes

a chemical change, the result of which is silicate of alumina, but it rarely or never happens that in any kaolin these two principles are found in the proportions in which they combine chemically; one or other is always in excess, and the result is consequently not an absolute silicate.

We have already stated that the first discovery of this precious and long sought-for material, soon destined to throw into the shade even the Chinese porcelain itself, was made in Saxony. The circumstances which led to it are curious and interesting, and highly characteristic of the spirit of the age, and of the interest which this manufacture excited.

An individual named Bottger, the apprentice of an apothecary at Berlin, rendered himself notable by his reputed skill in alchemy, pretending, and probably believing, that he was engaged in extraordinary researches which promised to lead to the solution of the grand problem of the transmutation of metals, and consequently to that of the fabrication of gold. These researches and pretensions gave him the title of the *Maker of Gold.*

The reports of his proceedings and his reputation excited the attention of King Frederick William I., who manifested such an interest in them as alarmed Bottger for his personal safety. Fearing that the King might seize his person with a view of extracting from him his secret, or at least of turning to His Majesty's exclusive profit his labours, Bottger fled from Berlin and took refuge in Saxony. The King of Prussia having caused him to be pursued, he was arrested at Dresden; but Frederick Augustus I., King of Poland and Elector of Saxony, having also some faith in the reputed discoveries of Bottger, and desiring himself to retain possession of the *Maker of Gold,* resolved not to surrender him, and consequently caused him to be conducted to Wittenberg. He was destined, however, only to exchange one captivity for another,

for the Elector, while he supplied him most liberally with all the means of pursuing his chemical researches, and contributed by every means to his personal comfort and well-being, had him kept under the most strict surveillance, and, in fact, he was subject to something approaching to solitary imprisonment.

These events took place in 1701. The King, after a time, finding that no results proceeded from the experiments of Bottger, and perhaps ceasing to have faith in them, put him in communication with a certain Tschirnhaus, who had been engaged in experimental researches relating to the fabrication of porcelain. He thought it probable that the skill and knowledge which failed in the solution of the problem for the fabrication of gold might probably be turned to account in the more practicable problem of the fabrication of porcelain. Tschirnhaus accordingly dissuaded Bottger from pursuing a course of inquiry likely to be so barren as that in which he had been so long and so vainly engaged, and allured him, by the prospects of wealth and distinction, to cooperate in a series of experiments, having for their object the discovery of the composition of the clay or paste of which the porcelain of China was composed.

Tschirnhaus had already discovered a clay in the neighbourhood of Dresden, of which he succeeded in making an earthenware, which was dense, compact, and hard, but red in its colour, and possessing not the slightest transparency. It had none of that translucency, whiteness, and fineness of grain which characterised the Chinese porcelain; it was, in fact, nothing better than a fine red ware; nevertheless, it had considerable vogue.

In order that he should be more effectually withdrawn from the observation of the curious, the Elector established Bottger, with Tschirnhaus, in the chateau of Albrechtsburg

at Meissen. A laboratory and workmen were there provided for him by the Elector. He was supplied with everything which could render his life agreeable, including a carriage for his use, but was still kept under incessant surveillance. Whenever he went out an officer accompanied him, who never for a moment lost sight of him, lest he should escape, taking with him his secrets. In 1706, Charles XII., King of Sweden, entered Saxony. The Elector, fearing that Bottger might be seized and taken away on this occasion, caused him to be conducted, with Tschirnhaus, and three of his principal workmen, under an escort of cavalry, to the fortress of Kœnigstein, to which his laboratory was also transferred. He was there subjected to a still more rigorous surveillance.

After a year's seclusion in this fortress, he was reconducted to Dresden on the 22d of September, 1707, where he was established with a new laboratory, which the Elector caused to be prepared for him in the Jung Ferbastei. Here Bottger and Tschirnhaus renewed their labours for the improvement of porcelain, and especially for the discovery of some means of making the porcelain of China. The researches were long and fatiguing, often occupying entire nights, and it is related that Bottger frequently found it necessary to watch incessantly the operation of baking for three or four days, night and day, during which he and his companion were compelled to keep incessant watch.

The Elector took a deep interest in these proceedings, so much so that he frequently himself assisted personally at them, and was present during the baking of the porcelain, and witnessed its being withdrawn from the ovens. The result of these labours was not, however, a true porcelain; it was still a reddish stoneware, which acquired the brilliancy of porcelain either by being polished upon the wheel of a

lapidary, or by means of a glaze produced upon it at a low temperature.

Tschirnhaus died in 1708, and a short time afterwards accident, which proves to have played so important a part in the history of porcelain, brought to the knowledge of Bottger the kaolin, or china clay, which afterwards conferred such celebrity upon the Dresden porcelain.

At this time hair-powder was in universal use, and formed an important article of commerce. A rich iron-master of Erzgebirge, named Schnorr, happened, in 1711, to pass on horseback along a road near Aue. He observed the road to be covered with a white and soft clay, which formed a tenacious mud, from which his horse raised its feet with difficulty. It occurred to Schnorr that an earth so white, when calcined and prepared, might be converted into a mineral hair-powder. He accordingly brought home with him a sample of this clay, and, having subjected it to certain processes, produced from it a fine white powder, which he afterwards fabricated on a large scale, and in which he established a considerable commerce at Dresden, Leipsic, Zittau, and other principal places.

Bottger, like others, wore a wig and used hair-powder. Happening one day to take in his hand the packet of powder supplied by his valet, he was struck with its extraordinary weight; he inquired whence it came, and ascertained that it was the new mineral powder, and not the vegetable powder which had been previously in general use. It occurred to him that an earthy matter of this whiteness might probably serve the purposes of porcelain clay, and he immediately subjected a quantity of it to experiment, and found it answer perfectly. Inquiries were now instituted respecting its origin. Schnorr was applied to, and the place at Aue where he obtained the powder was ascertained. On examination, this

proved to be a vein of fine kaolin, identical in its properties with that which constituted the material of the finest porcelain of China. This clay was then known in commerce as the *white earth of Schnorr.*

When these facts became known to the Elector, its exportation was strictly prohibited under the most severe penalties, and it was transported to the porcelain works of Bottger, by sworn agents and in sealed barrels. The most extraordinary precautions were taken to maintain the secrecy of the use of this earth in the fabrication of the Dresden china. The first condition imposed upon the persons employed in the works, from the highest to the lowest, was *secrecy till death!* A solemn declaration and oath were exacted monthly from the foremen of all the departments of the manufactory, and it was inscribed upon the doors of all the workshops; whoever betrayed any of the secrets was menaced by the King with imprisonment for life in the fortress of Kœnigstein.

A porcelain paste, having all the qualities of hardness, fineness, and translucency which characterises the porcelain of China and Japan, being now obtained, the Elector established a royal manufactory of porcelain at the Chateau of Albrechtsburg, at Meissen, already mentioned, and appointed Bottger director of the manufactory. As a further means of secrecy, the chateau was subject to the conditions and discipline of a fortress. It was approached by a drawbridge, which was never lowered except at night, and the entrance was interdicted to all except those employed in the manufactory. Even when the King introduced distinguished strangers to see the works, all the processes of manufacture were carefully concealed from them.

Such was the origin of the manufactory of porcelain which has since obtained a world-wide celebrity as the seat of the

Royal porcelain works at Dresden, and the source which has supplied to Europe, for more than a century back, the most admired productions of that manufactory, and which has furnished the Crystal Palace with some of its most precious treasures of art.

The kaolin of Aue, discovered by the accidental circumstances we have related, continued and still continues to be used as one of the materials of the Saxon porcelain. Two sorts of paste are, at present, used in this manufacture. What is called the service paste, or that used for porcelain in general, is composed as follows: —

Kaolin of Aue	18
Kaolin of Sosa	18
Kaolin of Seilitz	36
Feldspar, &c.	28
	100

For the statuary porcelain, the feldspar of Carlsbad and quartz are mixed with the kaolin of Aue.

Notwithstanding the futility of the means resorted to for keeping secret the processes at Meissen, they were continued with the same rigour long after most of the processes and materials used in the manufacture of Dresden porcelain became known, and when other manufactories of fine porcelain had been established in various parts of Europe.

So late as the year 1812, the late M. Brogniart, director of the Royal manufactory at Sèvres, was sent by the Emperor Napoleon to inspect the porcelain works of Germany, and, among others, he visited those of Meissen. So rigorous, however, was the system of exclusion and secrecy then practised, that in order to obtain admission, the King, at the spe-

cial request of Napoleon, solemnly released M. Kuhn, the director, from his oath of exclusion, so far as related to M. Brogniart, but refused to extend the same favour to the associate who had been sent with Brogniart by the Emperor.

While the fabrication of porcelain thus made progress, as explained in our former article, in Germany, a factitious paste was introduced in France, of which a porcelain was manufactured, since known by the title of *tender porcelain*, as distinguished from the *hard porcelain* of Germany and China. This ware, fabricated by a process complicated and expensive, differed altogether from the porcelain of China and Japan, and, in spite of its brilliant qualities and the gorgeous ornamentation of which it was eminently susceptible, means were still sought in France for fabricating a hard porcelain, which were not discovered and brought into practice for 60 years after the establishment of the manufactory of Meissen.

At length a vein of clay of the finest quality was discovered by accident, which again played a remarkable part in the history of this manufacture. Madame Darnet, the wife of a village surgeon, residing at St. Yrieix, near Limoges, accidentally found in a valley in the neighbourhood of that town a white unctuous earth, which she regarded as being capable of being rendered useful in the washing of linen. With this purpose she showed it to her husband, who, better informed, suspected other and more valuable properties in it, and undertook a journey to Bordeaux to submit it to a chemist of that place, named Villaris. This person, who had been already informed of the qualities necessary for porcelain clay, and of the eagerness with which it was sought for, suspected that the specimen brought to him by M. Darnet possessed these qualities. It was accordingly sent to Macquer, the chemist at Paris, who

was then occupied in experiments on the improvement of porcelain. He immediately recognised in this specimen of clay the true kaolin, and went to St. Yrieix in August, 1768, where he found a large vein of this precious material. Experiments were made upon it upon a considerable scale at Sèvres, where all doubts upon the subject were soon removed; and the kaolin of St. Yrieix, near Limoges, was immediately adopted as the material, and the fabrication of the hard porcelain was commenced.

M. Brogniart relates a curious and interesting anecdote connected with this subject. He says that, in 1825, being at Sèvres, where he was still director, an aged woman addressed herself to him one day supplicating temporary relief, and apparently suffering from extreme want. She asked for aid to enable her to return on foot to St. Yrieix, whence she had come. This woman was Madame Darnet, the discoverer of the kaolin of Limoges. The relief she sought was immediately given to her; and, on the application of M. Brogniart, Louis XVIII. granted her a small pension on the civil list, which she enjoyed till her death.

The progress of the manufacture of porcelain in France was marked by two epochs—the first commencing from 1700, about which time the manufacture assumed a national character, and the second commencing in 1765, the date of the discovery of the kaolin of Limoges.

During the first interval the French porcelain was that known by the name of the *porcelaine tendre*, or tender porcelain. This ware consisted of an artificial paste which contained no porcelain clay whatever. It was composed of nitre, sea salt, alum, soda, gypsum, and sand, which, being reduced to a frit, was mixed with about one-third of its own weight of white chalk and calcareous marl. The paste thus prepared, having scarcely any plasticity, did not admit of

being shaped in a moist state on the potter's lathe, and was with difficulty even moulded. When the article was roughly joined by moulding, and rendered hard by exposure to the air, it was put upon the wheel and reduced with a cutting tool to its exact form. But, as it was liable, from its want of tenacity, to crumble in this operation, a solution of tragacanth gum was added to it, to which was attributed the saline efflorescences which were occasionally manifested on the articles fabricated. In the process of turning the moulded pieces a saline and silicious dust was produced, which was extremely injurious to the potters, and caused asthmatic and pulmonary complaints. This was one of the reasons why the fabrication of tender porcelain was the more readily discontinued after the discovery of kaolin.

Owing to the want of plasticity and coherence in this artificial paste, great difficulties were encountered in the several stages of its manufacture. The want of tenacity rendered it necessary, when the articles were placed in the oven, to support all the projecting parts during the process of baking; and, in order that the forms of these parts might not be distorted, it was necessary that their supports should be formed of the same paste as the articles themselves, so that the whole mass, including the supports, might contract together. The linear dimensions contracted in the baking by one-seventh, and, consequently, the bulk or volume of the article was diminished in the proportion of three to two.

The epithet *tender*, applied to this porcelain, must not be understood as implying the quality of softness. It is intended, on the other hand, to express two qualities by which it is distinguished from the hard porcelain: first, that the paste is fusible at a certain temperature lower than that at which the hard porcelain is baked; and, secondly, that

the glaze is so soft that it may be scratched with a steel point.

The Royal manufactory of Sèvres continued to fabricate this tender porcelain exclusively until the discovery of the kaolin of Limoges, already mentioned, in 1765. After that time both kinds of porcelain, the hard and the tender, were manufactured, but the former in much larger quantity. The fabrication of the tender porcelain was not altogether discontinued until 1804.

Among amateurs in porcelain, including even those who are otherwise well informed, there prevails a notion that the art of fabricating the tender porcelain of Sèvres has been lost, and that, since it is impossible to reproduce the articles, they must necessarily have a high value in the market. This, however, is erroneous. All the materials and processes for the fabrication of this description of artificial porcelain are preserved at Sèvres, and the manufacture can be re-established whenever it is desired to do so. Indeed, we are informed at this moment that the Administration entertains an intention of recommencing the fabrication of this description of porcelain for articles of ornament, such as vases, pictures, &c., the imperfections incidental to it not affecting such objects.

All the Sèvres porcelain sent to the Exhibition was of the kind called *hard*, that being the only description fabricated in Sèvres for the last fifty years.

The portraits of the Queen and Prince Albert, in the great aisle of the Crystal Palace, are fine specimens of the largest porcelain painting which have been produced at Sèvres. These portraits, after Winterhalter, were executed by command of Louis Philippe, and presented to the Queen. They were commenced before the Revolution of February, but not finished until afterwards. Louis Philippe claimed

them as his private property, and they were surrendered to him by the Republican Government; but the portrait of Prince Albert had met with an accident, by which it was broken. Louis Philippe desired to have another made, but the Queen would not hear of this expense being incurred; and, the fracture being repaired at Sèvres, the portraits were sent to England and delivered to Her Majesty. The portrait of Her Majesty is by Ducluzeau, and that of Prince Albert by Bezanget.

Among the splendid collection of paintings and vases exhibited by the National manufactory of Sèvres, the most valuable and most worthy of attention and examination are the following: —

The painting of the Virgin, known as the *Vierge au Voile*, by Madame Ducluzeau, is copied from the celebrated picture by Raffaelle in the Louvre. The porcelain is of the same magnitude as the original, and measures 26 inches by 19. This work was executed in 1847–8, price 1000*l*. Another painting after Tintoretto, on a plate of porcelain 45 inches high, by Madame Ducluzeau, price 880*l*. A flower subject on a plate of porcelain, 40 inches high, by M. Jacober, 800*l*. A portrait of President Richardeau, by M. Beranger, 440*l*. A portrait of Vandyck, by Madame Ducluzeau, 280*l*. A painting on a plate of porcelain, 8 inches high, reduced from Raffaelle's "Madonna," by M. Constantin, 100*l*. A large cup, 45 inches diameter and 34 inches high, porcelain biscuit; the three principal figures upon the cup represent Industry in the fields and the workshop, and Education; the three corresponding medallions represent Ceres, Vulcan, and Minerva; around the foot of the cup are grouped three figures representing the Fates. This work was designed by M. Dieterle, the bas-relief and figures round the foot by M. J. Feuchères, and the cup itself was produced by the

process of casting (*coulage*) by M. Greder, *320l.* A vase, egg shape, 40 inches high and 16 inches diameter, flowers painted on blue ground, by M. Schilt, *320l.* A vase of antique form, decorated with flowers and buds, by M. Schilt, *240l.* A pair of vases, blue ground, ornamented in Indian style, executed by MM. Richard and Merigot, after the designs of M. Dieterle, 36 inches high and 13 inches diameter, *240l.* A vase, 40 inches high and 35 inches diameter, ornaments incrusted in coloured paste under the glaze, *200l.* A pair of vases, Chinese design, executed by casting (*coulage*), sea-green ground, flowers and birds modelled upon the ground in white and coloured paste, by Fischbag, after the processes invented by M. Louis Robert, superintendent of the painting department at Sèvres, designed by M. Dieterle, 40 inches high and 19 inches diameter, *112l.* A vase of antique design, 32 inches high and 16 inches diameter, ornaments in gold on a blue ground, by M. Frugenard. The manner of this painting is essentially different from the usual painting on porcelain. The painting in this case has been executed on the unglazed porcelain, and the painted surface lies between the porcelain paste and the glaze. A pair of vases, 28 inches high and 15 inches diameter, landscapes representing the Seasons, composed and executed by M. J. André, the ornaments by M. Barriat, *216l.* A pair of vases, of new design, by M. Klagman, 24 inches high and 16 inches diameter, illustrative of agriculture; one of the principal bas-reliefs represents the horse, surrounded by allegorical figures representing force, swiftness, courage, and beauty; the other represents oxen, escorted by the four Seasons; the lesser bas-reliefs represent pastoral subjects. These vases were executed by the process of casting by M. Greder, *80l.* A pair of vases, after the antique, 20 inches high and 10 inches diameter, executed by M. Barriat, after

the designs of M. Hamon, 72*l.* A pair of vases, called the Vases of Lesbos, decorated with figures, composed and executed by M. Roussel, ornaments in gold and colours, by M. Riton, after the designs of M. Dieterle, 168*l.* A pair of vases, called the Rimini vases, 19 inches high and 11 inches diameter, painted in blue, by M. F. Regnier, and ornamented in gold by M. J. Richard, 72*l.* A pair of similar vases, representing proverbs, composed and executed by M. Roussel, and decorated by M. Richard after designs by M. Barriat, 72*l.* A large cup, of Chinese design, 32 inches diameter and 24 inches high, sea-green ground, ornaments in white and coloured paste, executed by M. Mascrit after the designs of M. Dieterle, 40*l.* A large cup, Chinese model, blue ground, handles and rich mounting in bronze gilt, by Boquet; the models of the mounting by M. Choiselet, after the designs of M. Dieterle, 160*l.* A cup, after Benvenuto Cellini, 16 inches high and 13 inches diameter, painted in blue by Regnier, 100*l.*

The style of the Dresden porcelain is familiar to all amateurs, and, whatever difference of opinion may prevail as to its taste, there can be none as to the admirable excellence of its execution. All who have visited the collection at Dresden, will be familiar with the series of animals, represented on a scale approaching to the natural size, including bears, rhinoceroses, vultures, peacocks, &c., made for the grand staircase which conducts to the electoral library. These were fabricated as early as 1730. At a later period, when the manufacture had undergone improvements, large ornamental pieces of porcelain were made, such as the slabs of consoles and tables, some of which measure from 45 to 50 inches by 25, and are richly decorated with flowers.

Among the objects exhibited were more especially observed two magnificent vases, one after a design by Semper,

decorated with painted medallions and gilding, and another ornamented with painted figures and flowers after Watteau. The frame of a mirror, richly decorated with coloured flowers in relief and girandoles, was also much admired.

This frame, and the vase after Watteau, were priced at 150*l.* each, and the vase after the design of Semper, at 127*l.* 10*s.*

Among the varieties of Dresden porcelain the grotesque figures and groups have always been much admired for their execution, if not for their style. The costumes are especially admirable, and the representation of fine work, such as lace, truly wonderful. Some specimens of this were seen in the Exhibition. One of the grotesque pieces which has attained most celebrity, and is familiar to all amateurs, is the famous tailor of the Count de Bruhl, a figure which is remarkable for the difficulty of its execution owing to the numerous accessories which it includes. The figure of the tailor is represented riding on a goat surrounded with all the implements and appendages of his trade, and is about 20 inches in height. This celebrated group was composed by Kündler in 1760, and is usually sold for about 12*l.*

The Dresden manufacture has always been remarkable for its representation of flowers; and a beautiful specimen of this work was in the Exhibition, consisting of a *camellia japonica* with leaves and white flowers in porcelain, in a gilt pot, on a stand of white and gold porcelain. This article is priced at 90*l.*

Among the other articles exhibited by the Royal manufactory of Meissen may be mentioned two vases of light blue, with portraits of the Queen and Prince Albert, adorned with escutcheons filled with flowers and rich gilding, with postaments of a like description; a girl playing a guitar, with laces; a fluteplayer; an etagére with girandoles in flowers in relief; a picture of the lacemaker, after Slingeslandt, price 50

guineas; a figure of Ganymede, after Thorwaldsen; and statuary porcelain.

Besides the ornamental porcelain exhibited by the Royal manufactory, two collections of paintings on china after classical pictures were exhibited by the well-known artists of Dresden, Henry Bucker and Gustavus Walther. M. Bucker exhibited 11 paintings in gilt frames, from Correggio, Carlo Dolce, Titian, Murillo, Gessi, Guido Reni, Raffaelle, Mengs, Pattoni, and Leotarde. The prices of these paintings vary from 6*l.* to 20*l.* The same artist exhibited 18 paintings of larger size, varying from 18*l.* to 90*l.*, after Murillo, Titian, Holbein, Guido Reni, Correggio, Raffaelle, Sasso Ferrato, Ruysdael, Claude Lorraine, &c.

M. Walther exhibited six large paintings, varying in price from 16 to 42 guineas, after Cignani, Correggio, Guido Reni, Murillo, and Raffaelle.

The Imperial manufactory of porcelain of Vienna was established in the year 1744. One of the foremen of Meissen, named Stobzel, had deserted from that establishment about the year 1718, and escaped to Vienna, where, aided by a Belgian named Pasquier, and favoured by a privilege, or a sort of monopoly, for twenty-five years, granted to him by the Emperor Charles VI., he established in 1720, a small porcelain manufactory. Not having, however, sufficient capital to carry it on, it declined, and was finally purchased by the Empress Maria Theresa in 1744, and erected into a Royal manufactory. During nearly twenty years it required considerable subsidies for its support, but at length, by good management, it became profitable in 1760, and in 1780 yielded an annual profit of about 4000*l.* The number of operatives who were lately employed in this factory was about 400. The kaolin or porcelain clay used in this factory, until 1812, was obtained from the neighbourhood of Passau, on the con-

fines of Bavaria, and from Prinzdorf, in Hungary. Lately, however, it has been supplied by clay obtained from the neighbourhood of Brün, in Moravia, and Unghbar, in Hungary.

As deserters from Meissen were instrumental in establishing the manufactory of porcelain at Vienna, deserters from Vienna soon spread the knowledge of the art to a greater or less extent in other parts of Germany. Thus Ringler, one of those who had originally deserted from Meissen to Vienna, again escaped from Vienna to Munich, where he was appointed director of the porcelain works established in 1758 at Nymphenburg, within a few miles of that city. This establishment still continues, and is now the Royal porcelain manufactory of Bavaria. The white biscuit is manufactured at Nymphenburg, and its ornamentation effected in workshops at Munich. The porcelain clay used in this manufactory is obtained near Passau, already mentioned, the felspar from Raberstein, in Bavaria, and the quartz from Abensberg, near Ratisbon. It was, in like manner, by means of information brought by deserters and runaways from factory to factory, that the fabrication of porcelain came to be established successively in the Royal manufactories of Louisberg near Stuttgard, at Berlin, Copenhagen, Brunswick, and St. Petersburgh.

After the peace of Hubertsburg, Frederick II. of Prussia, erected the Royal manufactory of Berlin. While he was master of Dresden, he sent a considerable quantity of the porcelain clay of Meissen, and several of the operatives of this factory, to Berlin, to aid in the establishment of the manufactory in that city.

The first English porcelain was manufactured at Bow and Chelsea, near London, the paste being composed of a mixture of the sand from Alum Bay, in the Isle of Wight, with a plastic clay and powdered flint glass; this was covered

with a leaden glaze. This manufactory had considerable success.

In 1748, the manufacture was transferred to Derby; and in 1751, Dr. Wale established at Worcester a manufactory of tender porcelain, called the "Worcester Porcelain Company," which still exists, though in other hands. To Dr. Wale is attributed the invention of printing on porcelain, by the transferring of printed patterns from paper to the biscuit. The proposed design is first engraved on copper, and, the colouring matter being applied to the engraving in the same manner as in common copper-plate printing, the design is transferred to paper. This paper is afterwards applied to the biscuit, to which the colouring matter forming the design adheres. The paper is then dissolved and washed off, the colouring matter forming the design remaining upon the biscuit. The biscuit is then glazed over the design with a glass glaze, so that after vitrification the design appears under the glass.

The original Worcester Porcelain Company principally limited their business to the manufacture of blue and white porcelain, in imitation of that of Nankin, and making the Japanese pottery. Cookworthy, of Plymouth, continued to carry on the porcelain business at Worcester until 1783, when the manufactory fell into the hands of Mr. Thomas Flight.

About 1751, Messrs. Littler, Yates, and Baddeley attempted the same manufacture in Staffordshire, but without success, and it was not until 1765 that Messrs. Baddeley and Fletcher succeeded in the manufacture of porcelain at Shelton.

The potter's clay, or "china-clay," as it is technically called, which is used in the British manufacture, is found in the counties of Cornwall, Devon, and Dorset. That of Cornwall, which was discovered about 1768, by Cookworthy,

is the most esteemed, and its introduction into the manufacture of porcelain gave that business a great impulse. The Cornish "china-clay" consists of the decomposed felspar of granite, and undergoes a previous preparation in Cornwall, before it is transported to the seats of the porcelain manufacture. The following is given as the mode of preparation. The stone, broken previously by the pickaxe, is laid in a running stream, by which the light argillaceous parts are washed off and kept in suspension, the quartz and mica subsiding. The stream, carrying with it the matter suspended, is conducted to a sort of catchpool or reservoir, where the water remains in repose until the pure clay suspended in it is deposited. The water is then drawn off, and the bed of clay remaining at the bottom is cut out in square blocks, and placed on shelves, where it is exposed to currents of air and dried; prepared thus, it has a brilliant whiteness, and when crushed, is reduced to a fine-grained powder. In this state it is sent to the Potteries, under the name of China-clay.

In 1772, the manufacture of fine porcelain was completely established in Staffordshire, twenty-one years after its establishment at Worcester, and the manufactory continued to be directed by Mr. Richard Champion, the successor of Brown and Cookworthy, until 1782.

In 1800, Spode fabricated a porcelain very superior to all that had preceded it in England, and endeavoured to imitate, not without considerable success, the ancient tender porcelain of Sèvres. He also introduced, or at least improved, the application of calcined bones in the paste, an improvement which has since been carried much further. This establishment of Spode is now represented by Alderman Copeland, and constitutes one of the most extensive of the British porcelain works.

If the British manufacturer have not yet attained that high excellence in the ornamental department of the manufacture of porcelain, and cannot produce paintings after the great masters, enamelled on large slabs of porcelain, to rival those of Sèvres and Meissen, he has proved, by the present Exhibition, that the day is not far distant when even those productions may be executed in Staffordshire, and that, meanwhile, he has outstripped altogether all rivals in the production of articles fitted for the common use, not only of the middle, but of the most affluent classes, at a price which puts all foreign competition at complete defiance.

In recording these advances in the manufacture of ornamental porcelain for common use, justice requires that the name of Josiah Wedgewood should be put prominently and honourably forward. That enlightened and public-spirited man found the Staffordshire Potteries fabricating only inferior wares, flimsy in their materials, and utterly deficient in taste and elegance in their forms. He surrounded himself with artists of talent, both British and foreign, and called to his aid all the improvements of science which had relation to the manufacture. The effect of his exertions has been, that the wares of that district are now not only brought into general use in England, to the exclusion of all foreign manufactures of the same kind, but English earthenware is sought for and celebrated all over the world, and nowhere more than in those places where foreign porcelain has been previously manufactured.

The following testimony of eminent foreigners, fully competent to judge of this matter, will corroborate this. M. Faujas de St. Fond (quoted in the article on porcelain in *Dr. Lardner's Cyclopædia*) says: —

"The excellent workmanship of English porcelain, its solidity, the advantage which it possesses of sustaining the

action of fire, its fine glaze, impenetrable to acids, the beauty and convenience of its form, and the cheapness of its price, have given rise to a commerce so active and universal, that in travelling from Paris to St. Petersburgh, from Amsterdam to the furthest part of Sweden, or from Dunkirk to the extremity of the south of France, one is served at every inn upon English ware. Spain, Portugal, and Italy are supplied with it, and vessels are loaded with it for both the Indies and the continent of America."

MM. St. Cricq and Lebœuf, in an official report, published in Paris in 1835, affirm that for the fabrication of useful ware the English have enormous advantage over the French — an advantage which in the cost of labour amounts to 100 per cent.

M. St. Amans, an extensive French manufacturer, says that the English surpass all other nations in the fabrication of a stoneware remarkable for its lightness, strength, and elegance, and also in printing blue figures upon it of every tint, equal to that of the Chinese, by processes of singular facility and promptitude.

Porcelain in general may be characterised as distinguished from the coarser earthenware as a pottery whose paste is fine-grained, compact, very hard, and faintly translucid. When submitted to the action of heat it undergoes a partial vitrifaction, from which it derives its translucency. It is not correct to say that whiteness constitutes a definite character of porcelain, inasmuch as there are fine porcelain pastes variously coloured.

It is very important to attend to and comprehend the distinction between the sorts of porcelain called hard and tender. Hard porcelain, which is, as already explained, the species universally fabricated in Germany and the East, is composed of the clay called kaolin, consisting of silica and

alumina, which is combined with a flux consisting of silica and lime, with a felspar, which in China is called "petungse." The glaze of this porcelain is earthy, and admits of no metallic or alkaline ingredient.

Tender porcelain, on the other hand, consists of a vitreous frit, which is rendered opaque and less fusible by being mixed with a calcareous or marly clay. Its glaze is an artificial glass, composed of lead, silica, and soda, potash, or other alkali. This porcelain is more vitreous and transparent, and more fusible, than the hard porcelain. It may, indeed, be fused if exposed merely to the temperature which is necessary to bake the hard porcelain. Its glaze, also, is more glossy and transparent, but less hard, than that of the hard porcelain, since it can be scratched with a steel point.

The English porcelain, with a few exceptions, belongs to the class of tender porcelain, and is not therefore composed merely of kaolin and petungse. It is baked at a much lower temperature than the German or Oriental porcelain. Being manufactured on a very extensive scale, with great economy and certainty, and comparatively small expenditure of fuel, it is sold at a moderate price compared with the fine porcelain, and how little inferior it is in external appearance was rendered evident by comparing the collections exhibited in the gallery of the northern transept with those found in the foreign departments.

The English porcelain may be considered as holding a place intermediate between the hard porcelain of China and Germany, and fine stoneware. It is distinguished from the first by the paste being more friable, and by its plumbiferous glaze, and from the second by its transparency and its stronger glaze.

Some English porcelain is called ironstone china, and is usually composed of 60 parts of Cornish stone, 40 of kaolin,

and 2 of flint glass; or of 42 of felspar, the same of kaolin, 10 parts of ground flints, and 8 of flint glass. The glaze for the first composition is made with 20 parts of felspar, 15 of flints, 6 of red lead, and 5 of soda, which are fritted together, and 22 parts of flint glass and 15 of white lead are added. The glaze of the second composition is made of 8 parts of flint glass, 36 of felspar, 40 of white lead, and 20 of ground flints. These constituents and their proportions are, however, subject to great variation, each manufactory having receipts and proportions peculiar to itself.

One of the branches of the manufacture of porcelain in which British industry and art has of late years had the start of the Continent, is statuary porcelain. This has been introduced within the last six or seven years by some of the enterprising Staffordshire establishments, and principally by those of Messrs. Copeland and Minton. It is now, however, fabricated in almost all the great Staffordshire works, and numerous specimens of it were seen in the Exhibition among the collections exhibited by Messrs. Copeland, Minton, Boote, Meigh, Keys and Mountford, Rose, Bell, &c. The Duchess of Sutherland, to whose munificent patronage the local manufacture of Staffordshire is so deeply indebted, was one of the first to perceive the capabilities of this material, and to encourage its extension and use. Gibson, the eminent sculptor, having his attention attracted to it by her Grace, declared it to be the next best material to marble, and expressed an earnest desire that some of his own works should be reproduced in this new form. By the permission of the Council of the Royal Academy, a reduced copy of his "Narcissus" was accordingly made at the manufactory of Alderman Copeland.

Nothing can be more interesting or beautiful than the process of producing this imitation of sculpture. Since its

first introduction, like all other novelties in the arts, it has undergone great changes and improvements. The statuary material was at first limited to a thin superficial coating laid upon a more common body. At present, however, the article is composed of one homogeneous mass of statuary porcelain. In this respect it is superior to the article first fabricated; but the process is much more difficult and liable to fracture, owing to the much greater degree of contraction which takes place in the oven. The linear contraction of this material in the process of baking is about one-fourth, so that a figure when moulded four feet high, and put into the oven, comes out only three feet high. The actual contraction of bulk corresponding to this linear contraction is more than one-half. The baked materials, therefore, are included in less than one-half the space occupied by the unbaked.

The process of fabrication is as follows: — The material being well mixed and rendered perfectly homogeneous, and the water combined with it being uniformly diffused through it by the most perfect kneading, it is reduced by dilution to the consistency of thick cream. This liquid, which is technically called "slip," is poured into the mould, which is formed of plaster of Paris or gypsum, and allowed to remain there long enough for the plaster, which is a porous and bibulous material, to absorb the water from that part of the slip which is in contact with the surface of the mould. The consequence is, that, after the lapse of a certain time, the mould is coated with a solid lining of the statuary clay of uniform thickness, within which lining the remainder of the liquid slip, from which the water has not been absorbed, is included. This liquid is then poured out of the mould, the solid coating of statuary clay remaining in the mould. The mould is then opened and the hollow cast taken out of it.

Since the absorption of the water by the gypsum will be

more or less, according to the length of time the slip is allowed to remain in the mould, a greater or less thickness may be given, within practical limits, to the solid shell of clay which forms the object produced. If the slip be immediately poured out, a coating will remain not thicker than an egg-shell; but, on the other hand, the thickness of which it is susceptible is limited by the point at which the plaster mould becomes saturated with the water imbibed from the clay.

We may observe here that a beautiful and interesting application of this process is presented in the fabrication of the extraordinary thin and light articles of porcelain called on the Continent "muslin porcelain." An article, such as a cup, of this kind is fabricated in the following manner:—

A cavity corresponding exactly in form with the proposed cup, is made in a block of plaster of Paris. This cavity is then filled with the creamy slip already described, which is allowed to remain in it for a few seconds, after which it is discharged from it. In this short interval, however, a certain degree of absorption has taken place, and the surface of the cavity remains covered with a thin coating of the dry porcelain clay. When this hardens, it is easily detached from the mould, and forms a cup of an extraordinary degree of tenuity. The handles and other projecting parts are made in separate moulds by the means above described with reference to objects of sculpture.

To return to the subject of sculpture, it is necessary to explain that a figure or group is cast in a considerable number of separate moulds, each separate part of the figure or group being separately and independently cast. In some instances as many as fifty moulds are required for a single group.

The cast taken from each of these moulds is first retouched, the seams produced by the junctions of the mould being cleaned

off by scraping the superfluous matter with a knife. The several parts of the figure or group are then united, each being placed and maintained in its proper position—a process of the greatest difficulty, and requiring the most consummate dexterity in the operator. The parts are united by applying slip to the surfaces in contact; but, the clay being in this state extremely tender and friable, the weight of the projecting parts would be more than the cement used for joining them together is capable of resisting. After the figure or group is well dried in the air, it is placed on "saggers," a name given to the props which are placed under every part of it, so that it is well and evenly sustained.

All the supports are made of the same material as the object itself, so that all sustain the same shrinkage in the oven. It is evident that the slightest inequality of contraction in the baking between the figure or group and its supports, or between different parts of the figure, compared one with another, would destroy the nicer definitions of outline and proportion, and cause a distortion which, even though it were minute in amount, would take away all value from the article.

When it is considered that perfect uniformity of contraction not only requires homogeneity of the material, absolute uniformity in the diffusion of the water which it has absorbed, and which in the process of baking must be expelled from it, but also the most absolute uniformity of temperature round all parts of the figure or group during the process of baking, it is truly wonderful how the artistic perfection of such an object can ever be preserved.

The difficulties attending this part of the process of fabrication may be conceived by following the several stages through which the article passes before the baking is completed. If we assume the length or height of the object fabricated to be twenty-four inches, the shrinkage in leaving

the mould before exposure to heat will be an inch and a half. After the several parts, which, as has been just explained, are moulded separately, and are separately subject to a like shrinkage, have been put together, and the seams produced by their junction have been cleaned off by the "figure-maker," the article is thoroughly dried in the air without exposure to heat. This process is necessary, because the quantity of moisture incorporated in this state is such that the expansion produced by exposure to an elevated temperature would cause fracture. In this process of air-drying, a further linear shrinkage of an inch and a half takes place. Thus, before being introduced into the oven, the linear dimensions, originally 24 inches, are reduced to 21 inches. Finally, when it is "fired" in the bisque oven, it is contracted to 18 inches. It loses, therefore, in the entire process, one-fourth of its linear dimensions, and consequently nearly one-half of its actual cubical bulk. Nevertheless, such is the consummate skill brought to bear on this beautiful manufacture, that in good specimens there is not the slightest discoverable distortion or defect of form or outline.

These observations will be fully borne out by a reference to any of the finer groups presented in the Exhibition, such, for example, as the Ino and Bacchus after Foley, or the Narcissus and Venus after Gibson. Bearing in mind what has been just explained, we cannot fail to regard with profound interest many of the objects exhibited in this department, which, indeed, are so numerous, that we find it difficult to select from among them those which may be considered most deserving of notice.

The group of Ino and Bacchus has been taken from an original marble by J. H. Foley, R.A., now in possession of the Earl of Ellesmere. The reduction of this statue was effected by Cheverton's process.

The figure of Sappho, three feet high, from the original marble of W. Theed, is entitled to attention, were it only for its extraordinary magnitude — a circumstance which immensely enhanced the difficulties and hazards of its execution. The original of this figure is the property of Prince Albert.

The following will also be found worthy of examination: —

The Indian Girl and the Nubian, by Cumberworth; the Prodigal's Return and Rebecca, by W. Theed; a Venus, by J. Gibson, R.A.; a bust of Juno (colossal), from the antique; the Goatherd, by J. R. Hyatt, R.A.; Sabrina, by W. C. Marshall, R.A.; a Dancing Girl, by W. C. Marshall, R.A.; Innocence, by J. H. Foley, R.A.; and Narcissus, by J. Gibson, R.A. (the three last executed for the Art Union of London as prize statuettes); Godiva, by M'Bride, executed for the Art Union of Liverpool; an equestrian statuette of Emanuel Phillibert, Duke of Savoy, by the Baron Marochetti; her Royal Highness the Princess Alice as Spring, the Princess Royal as Summer, the Prince Alfred as Autumn, and the Prince of Wales as Winter, from the original models by Mrs. Thorneycroft, executed for Her Majesty.

The large tripod for a conservatory, in Alderman Copeland's collection, claims to be the largest work hitherto attempted in statuary porcelain. It is from an original design by T. Bottam, an artist connected with the establishment.

It is impossible to contemplate this collection of imitation of statuary without being struck with the value of this branch of manufacture as a means of disseminating in a suitable material the great works of ancient and modern art, and placing them under the eye of the public in a manner and to an extent which could be accomplished by no means

hitherto known. It is probable that this branch of manufacture will be to sculpture what engraving has been to painting, but with a much closer affinity, colour and texture being added to design.

The British department of the Exhibition was extremely rich in ornamental porcelain, and, although no great novelty of manufacture was present, many improvements of detail were observed.

A dessert service was exhibited by Messrs. Minton and Co., original in its design, and novel in its principal features of ornamentation. The combination of statuary porcelain, which is the hard species, with the coloured and gilded porcelain, which is the tender species, is here attempted, and gilding on the statuary porcelain has been also successfully accomplished.

The turquoise ground on this porcelain is very little inferior to that of the old Sèvres. This colour resists the strongest vegetable and most of the mineral acids. The service consists of 116 pieces, the principal of which are two flower-stands, with figures representing the Four Seasons, two wine-coolers, with hunting groups, and two oval baskets, with oriental figures. Several of the pieces are supported by figures in statuary porcelain, with fanciful designs, and the plates, 72 in number, are perforated and richly ornamented.

This service was purchased by Her Majesty, and at the close of the Exhibition was to be sent to Vienna. It was said to be intended as a present to the Emperor, and will serve as a specimen of what our manufacturers can do in this department.

Among the articles in statuary porcelain purchased in the Exhibition by Her Majesty are the equestrian figures of the Amazon (after Feuchères), and Theseus, Flora, and Tem-

perance, from bronzes in the possession of the Duchess of Sutherland, and Love restraining Wrath, an original group.

Another striking example of the combination of statuary with painted porcelain is presented in the Parnassus Vase, exhibited by the same manufacturers, the *bas-relief* illustrating Apollo and the Muses.

Several vases in the Copeland collection are of novel design, executed in imitation of pearls and gems, inlaid in gold, and executed in coloured enamel.

The following articles, exhibited by the same manufactory, well merit attention: — Large porcelain vase, with blue and gold enrichments and wreaths of flowers; pair of large vases, Etruscan form, 28 inches high and 26 wide, *bleu de Roi* ground and ornamentation, with green scroll on burnished gold.

The progress made by the British manufacturers in imparting colours to fine porcelain, is manifested in a striking manner by numerous services and ornamental objects, which will be easily recognised in the collections exhibited. We would especially direct attention to the following: —

A set of vases with a Rose Du Barry ground, chased gold panels, wreaths of flowers, and musical emblems.

A large copy of the Warwick vase, with *bleu de Roi* ground, the embossments in silver and gold, chased and burnished.

A pair of vases, "Queen's colour" ground, richly decorated, with panels of raised and chased gold, imbedded with pearls, and having landscapes within the panels.

Several vases of novel design, executed in imitation of pearls, and gems inlaid in gold, and ornamented in coloured enamels.

Among the colours, in which great excellence has been attained, are a strong and brilliant green, a cobalt blue, *bleu*

de Roi, and the tint which has been denominated "Queen's colour." As illustrating these we may mention —

An assortment of dessert plates with various designs; a set with the Royal arms emblazoned in the centre, with foliated scroll border, and the Royal cypher; a set with Spanish views; a set with turquoise band and wreath of pansies; and a set with varieties of fruit in the centre, the blossoms and foliage forming the border. The two latter sets have been purchased by the Duchess of Sutherland.

The colours used in the ornamentation of porcelain are produced by the metallic oxides, combined with other substances, called *fluxes*, which facilitate their fusion. Several difficulties attend this part of the manufacture. The first arises from the fact that the colours, when laid on by the artist, are generally different, often totally different, from the tints which it is intended ultimately to impart to the work. The following are the oxides used to produce the tints indicated: —

OXIDES.	TINTS.
Gold - - - -	Crimson, rose, purple.
Iron, chrome, manganese, cobalt	Reds, black, brown.
,, uranium, chrome, antimony	Orange.
Crome, copper - - -	Green.
Cobalt, zinc - - -	Blue.

The fluxes are generally borax, flint, oxide of lead, &c.

Not only is the tint upon the palette of the artist different from that which it is his purpose to impart, but the tint actually imparted varies with the intensity and duration of the heat to which the article is exposed in the oven. Thus, for example, to produce a rose colour or crimson, the colouring matter laid on by the artist has the tint of a dirty violet or drab. In the oven it varies gradually, according to the intensity and continuance of the heat, first becoming brown,

then taking a dull reddish tint, which by degrees brightens into the desired colour. But having attained this point, if, through want of skill or attention on the part of the fireman, the exposure to heat be continued, the beauty of the colour will be irretrievably destroyed, being converted into a dull purple, and thus all the previous labour of the artist is lost.

Independently of these difficulties, is the risk of the article cracking in the oven, — a risk which is so much the greater as the magnitude of the object is augmented.

The ornamentation of the commoner sort of ware, in which a single colour is used, is accomplished by a process similar to that of copper-plate printing. The design being deeply engraved on a plate of copper, an impression is produced on paper by means of the ordinary printing-press. The colouring matter is so prepared that it can be transferred from the paper to the surface of the article to be ornamented, by merely pressing the paper on the article. If the design be thus transferred before the glaze is applied, it is dried so as to expel the oil mixed with the colour, and then covered with the glaze, which is vitrified in the usual way, and the design is visible through it. If the design is applied over the glaze, the colours forming the design are themselves vitrified upon the glaze.

One of the circumstances worthy of remark connected with the collection of porcelain exhibited by British industry, is the various and unexpected uses to which this material has been applied, — uses which will certainly be still more extended and still more varied as the improvements of the art now in progress are developed.

An example of this is presented in a chimney-piece of statuary porcelain, exhibited by Messrs. Minton. The advantages of this application of the material are many and obvious, among which are extreme durability, and not being

liable to stains from smoke and other causes, to which marble is subject.

There are also a variety of porcelain panels, plateaux, and slabs for the covings of fire-places, tops of consoles, toilet and chess tables, the panels of doors and window shutters.

Among the articles of this class exhibited are panels executed by order of Prince Albert for Osborne House, shutter and furniture panels, and toilet table, with porcelain slab and porcelain panels in the door and drawers, painted with wreaths of japonica on a rustic trellis, ordered by the Duchess of Sutherland.

Some large and costly panels of this manufacture are also exhibited in connection with Mr. Featham's display of grates, and among them some jewel designs executed for the mansion of Mr. Hope, in Piccadilly.

A great variety of slabs for washstands and tables of every description are exhibited, illustrating the admirable qualities of this material. It is capable of any style of decoration. Its surface being vitrified, its durability is insured. It is easily and perfectly kept clean, not being affected either by soap or acids.

In Pugin's Mediæval Court were exhibited specimens of porcelain tiles, slabs, and other objects, illustrative of the variety of purposes to which this material may be applied, and the variety of ornamentation of which it is susceptible.

In the basement were exhibited two large terra-cotta vases, modelled by the Baron Marochetti. These were exhibited by Minton & Co., and claim to be the largest ever made in this country in plastic material.

There were also two enormous garden-pots in stoneware, with medallions in statuary porcelain, after Thorwaldsen, representing the Four Seasons and the four stages of human life. These were well worthy of examination.

Messrs. Minton exhibited some specimens of encaustic, Venetian, and other ornamental tiles for flooring. This branch of the earthenware manufacture has recently acquired considerable importance, and an export business of some extent has been already established in it. A large quantity of this article is now exported to the United States and the colonies, as well as to certain parts of Europe. The palace of the Sultan at Constantinople is paved with this tiling, as as are also the House of Lords, Osborne House, and St. George's Hall, Liverpool. This flooring has got into very general use in churches, private mansions, conservatories, &c. It is as durable as marble, less liable to stains, and can be decorated with any design to suit the taste of the purchaser.

As a specimen of pottery on a large scale, the figure of Galatea, seven feet high, is deserving of attention. This claims to be the largest perfect object in pottery which has yet been produced in a single piece. Attempts are, we understand, being made, with some probability of success, to produce it in statuary porcelain.

As there are no excise or other regulations affecting the manufacture of earthenware, there are no official documents or records by which the actual extent of the manufacture can be ascertained with precision; but it is estimated that at the Potteries alone the value of the earthenware produced annually is about 1,700,000*l.*, and that the value of the manufactures of Worcester, Derby, and other parts of the country, may amount to about 750,000*l.*, making a total annual value of 2,450,000*l.*

The value of the gold consumed annually at the Potteries in the ornamentation of porcelain is 36,400*l.*, and, since about half that amount is consumed in the other seats of the manufacture, it may be stated that the total value of the

gold used annually in England in this manufacture is about 54,600*l.*

The quantity of coals consumed annually at the Potteries is 468,000 tons, and, about half that amount being consumed in other factories, it may be stated at about 750,000 tons — an amount equal to what is consumed in working all the railways of the United Kingdom.*

It appears from the official reports that, in 1841 — the latest year in which official returns have been made public— the declared value of the earthenware exported was 600,759*l.*; in 1837 the declared value was 563,238*l.* In the four years ending 1841, an increase, therefore, took place in this export trade of 37,521*l.* upon 563,238*l.* If this same rate of increase only has been maintained since 1841, the present annual export trade must have a declared value of a million sterling.

But, since the declared is known to be on an average one-fourth less than the true value, we may assume that the present total annual amount of the export trade in earthenware is about 1,300,000*l.*

The proportion in which this enormous export is distributed among the different countries of the world is exhibited in the following table. In the second column is given the proportion of every 100*l.* value exported received by each of the countries named in the first column, and in the third column is given the number of pieces of ware out of 10,000 received by each country respectively: —

* See Lardner's Railway Economy, p. 83.

Countries.	Per Cent. of the total Value.	Per 10,000 of Number of Pieces.
United States - - - -	37·58	3,560
North American British colonies - -	6·95	778
Brazil - - - - -	6·36	1,010
British East Indies - - - -	5·00	310
British West Indies - - - -	4·42	387
German States - - - -	4·28	401
Holland - - - - -	4·11	397
Foreign West Indies - - -	3·50	396
Australian colonies - - - -	2·69	216
Denmark - - - - -	2·31	257
Italy and Italian islands - - -	2·25	145
Sumatra, Java, and Indian islands - -	1·39	168
Spain and the Balearic islands - -	1·08	145
Western Africa - - - -	0·85	73
Cape of Good Hope - - - -	0·79	64
Channel Islands - - - -	0·69	65
Turkey - - - - -	0·67	55
Russia - - - - -	0·65	40
All other countries - - - -	14·43	1,533
Total - - - -	100·00	10,000

It appears from this table that the United States is our great foreign customer for this manufacture, taking in value 37½ per cent., and in quantity 35½ per cent., of our entire export. Of the remainder, our North American colonies, Brazil, and India, take 18 per cent.

In 1841, our export in this manufacture formed about 30 per cent. of its estimated total value. We have no returns later, but it is probable that at present the export forms a much larger proportion of the entire value fabricated.

III.

GLASS MANUFACTURE.

If we desired to produce an example of the injurious influence of fiscal interference in manufactures, none more striking could be found than that presented by the contents of the central north gallery of the Great Exhibition. It may be confidently affirmed, that had the system of excise, by which the manufacture of glass was oppressed before 1845, still been maintained, not only would that magnificent display never have been offered to the admiration of the world, but the Crystal Palace itself would have been a creation as impossible as the castle of Aladdin.

When we look at the actual condition of this beautiful branch of industry, and compare it with what it was under the *régime* of the excise, our only wonder is, that in a country enlightened by a free press, and governed in so great a degree as ours, by public opinion, a system so monstrous should have been tolerated for half a century. Nevertheless so it was. The fabrication of this most useful and necessary article was loaded with duties so excessive, and the processes of its fabrication were carried on under restrictions so stringent, and a surveillance so vigilant and incessant, that all improvement was impracticable. No experiments were allowed. One and one only mode of fabrication was tolerated by the ever-present exciseman. Even experimental trials in the laboratory of the philosopher, for purposes exclusively scientific, were interdicted.

The effects of this system were, the obstruction of all improvement in the art, the enhancement of the price to the consumer, the monopoly of the business in the hands of a limited number of wealthy manufacturers, the restriction of consumption, and the impossibility of exportation. While the population of the United Kingdom in the interval between 1801 and 1833, increased 50 per cent., the consumption of this manufacture was increased only 12 per cent. But what is still more remarkable, the average annual consumption in the three years ending 1791, was actually greater than in the three years ending 1834, although the population at the latter was about 100 per cent. more than at the former epoch.

A manufacturer who, by his skill and experience, succeeded in fabricating a very superior quality of bottle glass, was suddenly arrested in his proceedings by the exciseman, on the ground that the articles he produced were of a quality so excellent as to be undistinguishable from flint glass, to which a higher rate of duty was chargeable!

In any other country except the United Kingdom, manufacturers were at liberty to adopt whatever materials or processes were found best suited to their purpose, and consequently many articles, the fabrication of which, in England, was contrary to the excise regulations, were necessarily imported in spite of a heavy rate of duty exacted at the custom-house. Among these may be mentioned glass for optical instruments, which, until the relaxation of the excise, was almost wholly imported, the excise regulations having prevented the adoption, in the English glass-houses, of those processes which were necessary for the attainment of properties on which its optical utility depended.

The glass manufacture was, of course, not exempt from the evils which ever attend the imposition of high duties, by fostering a system of illicit fabrication, the extent of which is always in the exact ratio of the amount of the duty. The

materials of this manufacture are everywhere accessible, the processes simple, and the apparatus cheap. It could, therefore, be easily conducted by individuals in their private dwellings with few accessories and trifling capital. The alkali, which is one of its ingredients, and which formerly required, for its preparation, extensive space and costly apparatus, is now obtained in abundance and of the best quality from common salt. It is notorious that under such facilities and temptations, the illicit fabrication of glass was carried on upon a considerable scale in attics and cellars, to the injury of the revenue, the detriment of public morals, and the loss of the fair dealing manufacturer.*

These abuses and evils were abated by the total repeal of the glass duty in 1845. As a necessary consequence, the manufacturers reduced their prices in all cases by the full amount of the duty taken off, and in many in a still greater proportion; and the contents of the glass gallery of the north transept, many splendid objects in the aisles and avenues, such as the crystal fountain, and, in fact, the Crystal Palace itself, proclaim with eloquence not to be disputed, the wisdom of this policy. Indeed, this part of the Exhibition has been most gratifying; and if we still fall short of some of our neighbours of the Continent in certain classes of ornamental objects, there is every presumption that many years will not roll over before we shall come abreast of them in this ornamental art.

If the substance called in chemistry silica, which was formerly denominated, in popular language, the earth of flints, and which may be considered as a sort of siliceous sand, be exposed to the strongest heat of our furnaces, it will resist fusion; but if it be well mixed in a certain definite propor-

* Porter's Progress of the Nation, p. 256.

tion with an alkali, such as potash or soda, and the mixture be then submitted to a like temperature, chemical combination will take place, the silica will unite with the alkali, and a substance will result which will take the liquid form, and, when cooled, will be transparent. This substance is called *glass*, and the process we have here described is called *vitrifaction.*

The quality of glass depends on the proportion in which the siliceous matter and the alkali are combined, on the temperature to which they are exposed, and on the skill with which they are previously mixed and with which the entire process is conducted. When the siliceous matter does not unite perfectly with the alkali, it is seen in opaque particles in the glass which results, and other inequalities of structure, which produce imperfections called striæ.

Glass is distinguished into three sorts, according to the quality and proportion of the alkali, and according to the mode of manufacture — crown glass being that sort which is used for window-glass; plate-glass, that which is used for mirrors; and flint-glass, that which constitutes the materials of which all our ornamental articles, such as lustres, table-glass, &c., are made.

Messrs. Pellatt, Apsley & Co. exhibited a most interesting collection of models and specimens illustrative of the manufacture of this last article, consisting of specimens of glass of every description and in every stage of its progress of manufacture.

Besides the siliceous earth and alkali, this glass contains a large proportion of oxide of lead, which has the effect of increasing its density and brilliancy, and of rendering it more ductile and manageable in the manufacture, when in the semi-fluid state. The siliceous sand which forms the basis of the manufacture is found at Alum Bay, in the Isle of Wight, and at Aylesbury, in Buckinghamshire. This is combined with

the carbonate and nitrate of potash in the proportion of two-thirds of the former to one-third of the latter. A small proportion of the oxide of manganese is added; without this the glass would not be colourless, but would have a certain green tint. The whole art of producing colourless glass consists in the proper adaptation of this ingredient. How small a quantity of manganese affects the quality of the glass may be conceived, when it is stated that a single ounce of manganese will make an apparent difference in the colour of three tons weight of glass.

The usual proportion for the ingredients of flint glass is, three parts by weight of siliceous sand to two of lead, and one of alkali. The more exactly these proportions are adhered to, the more compact, homogeneous, and refractive will be the glass. By increasing the ratio of the alkaline constituent, the fusion and vitrification are facilitated, and on the Continent, in places where fuel is costly, the manufacturer is tempted to adopt this expedient for the sake of economy. The glass, however, suffers for it, being invariably deteriorated in quality. This is one of the advantages which the British manufacturer enjoys over the foreigner. In no part of Europe is fuel so abundant and cheap.

Messrs. Pellatt & Co. also exhibited the crucibles used for melting the glass, composed of Stourbridge fire-clay, which consists of a mixture of silica and alumina in the proportion of nearly two to one. A model of a patent glass furnace was also exhibited, the form and construction of which is such that it produces a reverberation of the flame from the centre towards all the parts of the circumference, and downwards between the crucibles, so that all the parts may be equally heated.

Specimens of the glass were exhibited in the several stages of its progress. After the first ten or twelve hours, it appears

as a sort of honeycombed mass, very white and perfectly opaque, as was seen in specimen marked No. 8. In the next stage, represented by No. 9., it becomes transparent, but is filled with thousands of bubbles of air; the white colour now gives place to a light purple tint, produced by the oxygen supplied by the manganese; as the melting continues this purple tint gradually disappears, the air bubbles are disengaged, and the glass is at length rendered fine and uniform, and ready for manipulation.

The various implements and tools used in this manufacture were also exhibited, consisting of the blowing iron, No. 10.; the workman's chair, No. 11.; the procellos, No. 12.; the punty, No. 13.; the shears, No. 14.; the battledore, No. 15.; and the pincers, No. 16.

Between the operations of glass-blowing and turning there is a strong analogy; but glass-blowing differs, inasmuch as, besides the action upon the outer surface by compression, an action from within is produced by blowing. Every shape which can be produced by the lathe can also be produced by blowing; all other shapes requiring to be formed in moulds.

One of the most beautiful and interesting departments of the art of the glass-maker consists in imparting to glass a variety of transparent colours. This is accomplished by adding to the usual ingredients of glass, as already explained, the oxides or carbonates of certain metals, which have the quality of imparting to the structure of the glass a quality in virtue of which it absorbs certain constituents of the solar light and transmits or reflects others.

It has been hitherto generally supposed that the oxides or salts of particular metals had the exclusive virtue of conferring particular colours upon the glass. Thus cobalt was supposed to have the exclusive property of producing blue, and copper green; but it has been very recently shown that any of the

colours may be produced by any of the ordinary metals, the colour varying according to the degree of heat to which the colouring matter is subjected. Iron, copper, cobalt, manganese, gold, and uranium are the metals chiefly used in imparting colour to glass. The shades of green, such as were shown in the specimen marked No. 18. of the collection of Messrs. Pellatt & Co., are produced by the oxides of iron and copper combined in different proportions, the yellow tints being due to the iron, the blue to the copper, and the green to their combination. Specimen No. 19. was a dull yellow-coloured glass produced by the carburet of iron; Specimen No. 20. a blue glass produced by the oxide of cobalt; the purple specimen, No. 21., produced by the oxide of manganese; and the varieties of rose and ruby glass marked 22. were produced by the oxide of gold. The oxide of uranium is said to produce the topaz specimen, No. 23.; and the same metal, with the addition of a small quantity of copper, produced the emerald green specimen, No. 24. It is not, however, only the colours of transparent gems which can be represented by this artificial process, but even the opaque stones. Glass is rendered opaque by the addition of arsenic, and the peculiar colour of opal, as shown in specimen No. 25., is produced by the addition of phosphate of lime.

But of all the processes introduced by modern art into glass-making, one of the most interesting and beautiful consists in the combination of different colours in the same object, which, combined with consequent cutting, produces the infinitely various effects which were observable among the ornamental articles exhibited. Nothing can be more simple than the process by which these effects are produced. The object being formed first in white transparent and colourless glass, and this glass being allowed to cool until it acquires solidity and consistency, it is dipped for a moment in a pot of

coloured glass in a state of fusion, and being suddenly withdrawn, it carries away upon it a thin coating of coloured glass, which immediately hardens upon it, and becomes incorporated with it. The article is then shaped by the processes of the glass-maker, and if it be afterwards cut, those parts which are cut will be clear transparent glass, the parts not cut remaining coated with the colour. It is by this process that all the effects which are seen in the ornamental articles which consist partly of coloured and partly of clear glass are produced. It is evident that an infinite variety of figures may thus be formed, the outlines of which will be marked by the boundaries of the coloured and clear glass.

Two or more colours may in the same manner be combined on the article after being coated as already described, since glass of one colour may be dipped in the same manner in glass of another colour in a state of fusion, so as to take up another coat of a different colour, and by cutting the surface of such objects to different depths varieties of effects may be produced, in which two or more colours may be combined.

The only difficulty in this process is the proper union of the several coatings of coloured glass, because if any difference exist in what glass-makers call the "temper" of the metal, the unequal contraction during the process of annealing may be such as to cause fracture.

The emancipation of this beautiful branch of industry from the bondage of the excise in 1845, gave a prodigious impulse to it, and a sudden extension of the business took place at all the seats of the manufacture, but, above all, at Birmingham, which has furnished so large a contingent to the great museum of industry, including the Crystal Palace itself. Under the *régime* of excise restriction, glass was manufactured at Birmingham, as well as in other places, only by large manufacturers. Now, however, it is produced

in large quantities by individuals of small capital, working on a more limited scale, at a cheap rate, and requiring quick returns. The glass thus produced is of an inferior quality, and commands a market only by reason of its extreme cheapness.

Meanwhile, the great manufactories, which previously monopolised the business, received a corresponding extension, and have been enabled, by their enormous capital, to reduce, in a corresponding proportion, the prices of the more expensive class of productions. No evidence of the power of these vast enterprises can be adduced more striking than the fact, that the glass which covers and encloses the great Museum of Industry has been supplied by a single establishment, without interruption to their ordinary business, and without preventing them from contributing largely to the collection which is displayed in it.

The establishment of Messrs. Chance, Brothers, and Co., exhibited a collection of specimens of crown window glass, in tables, illustrating various sorts of this article; and also sheet or cylinder window glass, of five different orders of weight or thickness, weighing severally 13, 16, 21, 26, and 32 ounces per square foot.

The Crystal Palace is glazed with sixteen ounce glass of this sort. Each pane measures 49 inches in length by 10 inches in width. The process of manufacture is as follows: —The glass-blower, having collected a lump of molten glass on the extremity of the iron blower, blows it by the common process into the form of a hollow sphere. It is then returned to the furnace and reheated until it becomes soft, when it is withdrawn, and swung round in an horizontal circle by the operator, who, in executing this manœuvre, places himself on the edge of a circular pit or trench. By the effect of the centrifugal force the sphere is elongated,

and takes the cylindrical form. When it has thus acquired the proper length, the ends of the hollow cylinder are cut off, and it is split longitudinally along one side, parallel to the axis of the cylinder. This is accomplished by touching the heated glass with a cold iron dipped in water. The sudden contraction produced by the contact causes the glass to split along the line traced by the iron. It is then opened out into a sheet, and placed on a flat slab in the flattening furnace, after which it is annealed, and the article is finished.

The glazing of the Crystal Palace itself presented formidable difficulties owing to the quantity of work to be executed, the position in which the panes were to be placed, and the short time within which it was necessary to complete the work.

"No sooner had the skeleton of the transept roof been completed," observes Mr. Wyatt, "than the work of glazing commenced. For a considerable portion of the height of the curve, ladders and temporary scaffolds enabled the workmen to proceed with their labours; but, in order to complete the upper part, an ingenious box was constructed moving on wheels in the line of the gutters. This box was lowered down from the lead flat at the summit to any portion of the roof.

"The glazing of the nave roof presented formidable difficulties, from the great extent of work to be got through in so short a space of time. The ingenuity of the contractors was, however, brought to bear upon the subject, and provisions were made by them for the simultaneous glazing of large areas, entirely independent of variation of weather. Seventy-six machines were constructed, each capable of accommodating two glaziers. These machines consisted of a stage of deal, about eight feet square, with an opening in the centre sufficiently large to admit of boxes of glass and supplies of sash-bars, putty, &c., &c., being hoisted through

it. The stage travelled on four small wheels, travelling in the Paxton gutters, and spanned a width consisting of one ridge and two sloping sides. In bad weather the workmen were covered with an awning of canvas stretched over hoops for their protection.

"In working, the men sat at the end of the platform, next to whatever work had been last done, from which they pushed the stage backward sufficiently far to allow them to insert a pane of glass; and, so soon as that was completed, they moved again far enough to allow of the insertion of another. In this manner each stage travelled uninterruptedly from the transept to the east and west ends of the building. The dexterity acquired by the men at working the machines was very remarkable. By means of these, 80 men in one week put in upwards of 18,000 panes of glass, being not less than 62,600 superficial feet. The greatest number of panes inserted by a man in one day was 108, being 367 feet 6 inches of glazing. A somewhat similar machine has been constructed for the purpose of effecting any repairs that may be necessary in the finished roof, with the difference that its wheels travel upon the ridges instead of in the gutters, and that, of course, there is no aperture for the purpose of hoisting."

Messrs. Chance also exhibited some beautiful specimens of painted windows, consisting of leaded work, with medallions in the early Gothic style. The figures of St. Paul and St. Peter, St. George and Britannia, are executed in the style of the fourteenth century.

Messrs. Bacchus and Son, of Birmingham, exhibited a variety of beautiful articles fabricated in the manner which we have described above, in which a coating of coloured glass being produced upon the article to be ornamented, it is afterwards cut in various figures. Among the articles ex-

hibited by Messrs. Bacchus, are vases enamelled on ruby and engraved; sugar basins, &c. enamelled on green, with gold leafage; goblets of various colours, cut and ornamented; a vase, chased, ruby and white, cut and ornamented; a jug, chased, enamelled on blue flint, engraved and gilt; green and ruby decanters, similarly cut.

Mr. Green, of St. James's Street, exhibited a beautiful collection of objects engraved in the Greek style, and the style of Francis I., with thistle and ornamental work, and engraved with various natural flowers. Among these objects was a pole fire-screen, with glass screen and pedestal gilt, a triple group of the water lily in glass, with or-molu stand and bronze leaves, the leaves and stem electro-silvered.

Messrs. Ballantine and Allan exhibited stained glass in the Elizabethan style, consisting of the window of the entrance hall of Glenormiston. This seat is held directly from the Crown, on the condition that the proprietor, when required, shall present the sovereign with a red rose on the festival of St. John. The pictorial part of the window represents the ceremony as performed in 1529, when the Scottish monarch passed through Peebleshire. An heiress, supported by a knight, presents the sovereign with a rose, a retainer displaying in the background the banner of St. John.

The crystal fountain, in the transept nave, which attracted so much attention and admiration, is the largest single object ever constructed of the same material. The altitude of this fountain is twenty-seven feet, and it contains not less than four tons of pure flint glass. This proceeds from the works of Messrs. F. & C. Osler, of Birmingham, who also exhibited several magnificent lustres in the same material, and busts of the Queen and Prince Albert, of Shakspeare, Milton, Scott, and Peel, in frosted glass.

These busts are produced by moulding, the rough surface

being produced by abrasion. Their effect, as the annotator of the Catalogue observes, is pleasing, and would indicate that larger works of like material and workmanship might be undertaken with advantage. The indestructible nature of the material, and its resistance to atmospheric influences, render it well fitted for statuary and monumental objects, which, in our climate, are so speedily discoloured and corroded when constructed of marble.

Messrs. Coathupes and Co., of Bristol, exhibited glass water pipes, plane, jointed, and angular, intended as a substitute for the iron pipes now used for the distribution of water through towns. The question of the water supply raises more debatable matter than merely the source from which the enormous quantity required for the supply of the metropolis is to be obtained. The question of distribution presents almost as many important considerations as the question of supply. Many waters, and those chiefly of great purity, are found to act chemically upon metallic pipes and cisterns generally used. The attention of the most eminent engineers and chemists is occupied with the solution of the problem of conveying the water from its source to the place of consumption without being contaminated *en route*, and among the projects proposed the substitution of glass for metal pipes is worthy of consideration.

Messrs. Rice, Harris, and Co., of Islington glass-works, exhibited a beautiful collection of table glass produced by pressure and moulding. The same firm also exhibited a variety of ornamental glass, produced in the manner already described, in various colours, transparent and opaque, imitating opal, alabaster, turquoise, amber, canary, topaz, chrysoprase, pink, blue, light and dark ruby, black, brown, green, purple, &c., the colours being produced chiefly by the oxides of copper and gold. The articles made in other colours are gilt,

enamelled, cut, and engraved, and consist of tazzas, liqueur services, compotiers, butter-coolers, sugar basins, toilet bottles, &c. In several of these objects the coatings of colours superposed upon one another amount to two, three, or even four colours. The external coats are cut through by grinding the outer layer, and the inner ones are thus laid bare, and the desired effect is produced. The gilding is produced by the brown oxide of gold, which is ground up with a flux, and eventually with a fat oil. It is worked with a brush, and is then submitted to the heat of a druffle sufficient to melt the flux. It is then laid to cool, when it presents a dim appearance. The brilliancy is finally given to it by burnishing with stone burnishers.

Messrs. David Greathead and Green, of Stourbridge, exhibited a large collection of glass objects, highly ornamented with colours and enamelling, including a great variety of vases and jars, for scents and flowers, in the Egyptian, Etruscan, and Grecian styles, cut, coated, gilt, painted in enamel colours after the antique, with figures, ornaments, flowers, landscapes, &c.

The enamelled colours are produced upon glass by a metallic base or oxide in connexion with a flux which melts and vitrifies at a lower temperature than the article to be ornamented or enamelled. The enamel is ground upon a glass slab with a glass muller and some essential oil, and is applied with a brush. A perfect knowledge of the effect of heat on colours is essential to a skilful enamellist. If the article be exposed to too great a temperature, the colour flies, or the object is distorted and rendered useless.

The glass manufacture, which now forms so important a part of the local industry of Stourbridge, was introduced there about the middle of the sixteenth century by a number of refugees from the province of Lorraine, under the direc-

tion of an individual named Henzole. The first glass-house was worked at a spot near Stourbridge, still known by the name of Hungary Hell. The existence of fire-clay and coal in the district might in some measure have determined the localisation of glass-making there, although the sand which constitutes so important a part of the material is brought from a distance.

The British manufacturers, profiting by the freedom from the restrictions of the Excise, have lately directed their attention to the improvement of glass for optical purposes, and the Great Exhibition presented evidences of the progress already made in this direction. The great refracting telescope exhibited in the nave, contained an object-glass measuring nearly a foot in diameter. So considerable has been the improvement made in the fabrication of this species of glass, that instead of importing, as formerly, all that is necessary for the English opticians, our manufacturers have now no inconsiderable export business, and supply a large part of the material used by foreign optical instrument makers. It is even affirmed that British optical glass has been occasionally re-imported at an advanced price, under the assumed character of foreign glass.

In fine, the rapid advances made in this branch of industry, since the very recent date of its emancipation in England, the great and numerous advantages which the British manufacturer enjoys over his Continental competitors, the unbounded supply of fuel at a low price, and the command of large capital, united with our national spirit of enterprise, justify the expectation, that the day is not far distant when we shall witness vast and various extension in the uses of this production, not only in ornamentation, but in domestic economy, and even in architecture.

IV.

RAILWAY MACHINERY.

On contemplating the stupendous machines displayed in the north-western aisle of the Crystal Palace, one cannot fail to be struck with the extraordinary progress made in the art of inland transport within a brief period of twenty years, especially if we compare these machines with the engines which were originally used on the Liverpool and Manchester Railway, the first line on which the locomotive engine was applied to the swift transport of passengers.

It will not be uninteresting or uninstructive to take here a brief retrospect of the progress which this great agent of inter-communication has undergone, the more especially as the main features which distinguished the original locomotive are preserved in the present machines.

That part of the locomotive engine employed to generate steam consists of three principal parts — the boiler, the fire-box, and the smoke-box. The boiler having a cylindrical form, the length of which is three or four times its diameter, is placed with its axis horizontal and parallel to the rails; behind it is the fire-box, and before it the smoke-box, so that as the machine progresses the boiler is preceded by the latter and followed by the former; the whole is supported on four or more wheels. The fire-box consists of a hollow

casing of metal, in the bottom of which are placed the grate bars, and under them the ash-pit; this casing is filled with water to a level above its roof, and the grate bars are placed below the bottom of the boiler.

The boiler is traversed longitudinally by a number of tubes, through which the flame and heated air proceeding from the furnace are conducted to the smoke-box. Over the smoke-box is erected the smoke funnel, or chimney, up which the heated air, which has thus traversed the tubes, is conducted, and from which it escapes into the atmosphere.

A vehicle called the tender, supported on four or more wheels, which carries a certain supply of fuel for the furnace and a tank containing a supply of water for the boiler, is attached to the engine. A pipe of communication, having a flexible joint capable of accommodating itself to the irregularities incidental to the motion, connects this water tank with the boiler, a force-pump being applied in such pipe of communication, by means of which the water is driven from the tank into the boiler. This force-pump, or feed-pump, as it is called, can be put in operation or suspended, as occasion requires, by the engine driver. Behind the fire-box is a stage which is flush with the floor of the tender, so that the engine-driver and fireman can pass freely from the one to the other. In the back of the fire-box is a small door, through which the fire-box is fed with coke.

Mounting upon the stage just described, several appendages will be observed, the use of which it may be interesting to indicate. At the back of the fire-box is usually attached a glass water gauge, the purpose of which is to enable the engineer to see the level of the water in the boiler. This is accomplished in the following manner: — It will be observed that the glass tube is attached to the fire-box in a vertical position, and communicates at its lowest and highest points

with the interior by pipes governed by stopcocks. Now, the position of this gauge is so regulated that when the right quantity of water is in the boiler, its level should be below the top and above the bottom of the glass tube, and as the water in the tube must stand at the same level as the water in the boiler, the engineer will know when the boiler requires feeding, by observing the water to fall in the tube to its lower extremity, and he will know when the feed has been sufficiently supplied by observing the level of the water in the tube rise somewhat above its middle point.

As these tubes are liable to accidental fracture, stopcocks are provided in rectangular brass tubes, which connect them at top and bottom with the boiler, which, being closed, the fracture of the glass tube produces no other inconvenience than that of depriving the engine of the gauge.

But even in this case provision is made by other means, which will be seen upon any of the engines exhibited.

Small pipes of discharge, furnished with stopcocks, will be observed issuing from the boiler at different levels. The engineer, on opening these stopcocks, severally, may at any time ascertain the position of the level of the water in the boiler, by reference to the points at which these tubes severally enter it. If, on opening either of these cocks, steam escapes, it shows that the level of the water is below that of the cock; if water escapes, it is above it; and as these cocks are placed at several different levels, the engineer is able to *feel*, as it were, by severally opening them, where the level of the water lies, and he acts accordingly in feeding the boiler.

A lever will be observed attached to the tender, which governs the feed, so as to throw the feed-pump in or out of action at the will of the engineer.

On the roof of the fire-box, generally on the left side, will

be seen a lever held down by a spring connected with an index and graduated scale. This spring governs the safety valve, which is fixed upon the roof of the fire-box, and the apparatus is, in fact, a spring steelyard, which measures the pressure of the steam in the boiler in pounds per square inch. A screw will be observed in connection with this steelyard, by which it may be so adjusted that the pressure of the steam will open the valve when it attains any proposed amount per square inch: thus the screw may be so adjusted that whenever the steam acts upon the valve with a pressure exceeding 60 lbs. per square inch, the valve will be opened and the steam will blow off.

When a train stops, as it does at the several stations along the road, the boiler continues to produce steam, which, accumulating, would soon attain a pressure that would open the safety valve, and it would escape into the atmosphere. An ingenious means is provided, by which this waste of steam is saved. Instead of allowing it to escape into the atmosphere, it is made to pass into a pipe, by which it is conveyed to the tank upon the tender containing the water intended to feed the boiler. The moment it enters the tank it is condensed by the cold water, and, mixing with it, raises its temperature. A gallon of water, in the form of steam, which thus enters the tank, is capable of imparting to nearly seven gallons of water contained in the tank, enough of heat to raise this quantity to the boiling point.

Every one who has travelled by railways will recollect that when the train stops at a station for any length of time he frequently hears a peculiar rattling noise produced in or near the engine, and that the noise immediately ceases when the engine begins to move. This noise is produced by the sudden condensation of the steam, escaping from the safety valve and entering the tank.

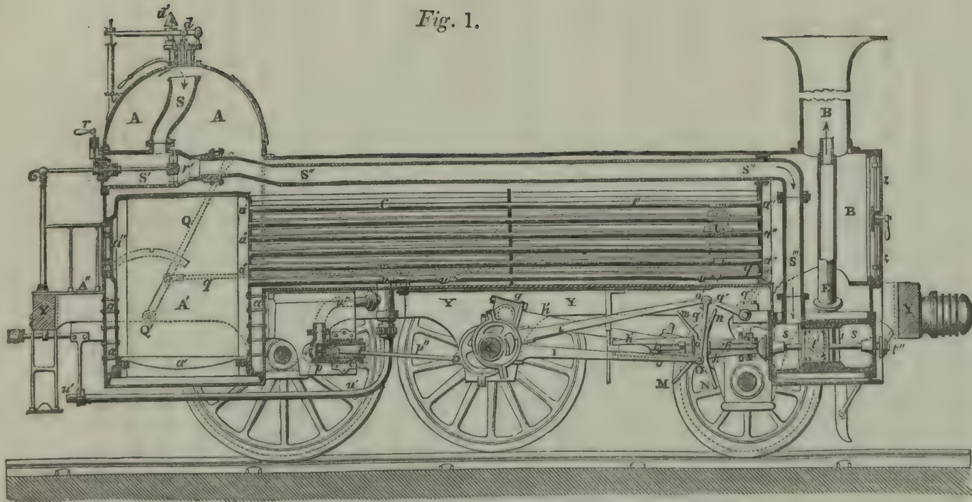
It will also be observed, that standing on the stage of the fire-box, and looking forward, two levers are placed on the right of the engine. These levers are what are called *way bars*, the purpose of which is to start the engine. When at rest they invest the engineer with a power of moving the valves two or three times successively, so as to conduct the steam alternately to each end of the cylinder, and thus to cause the motion of the piston to commence. After the motion of the piston has once commenced, the inertia of the machinery and the self-acting mechanism will cause its continuance.

Attached to the back of the fire-box will also be observed a lever, which is usually made to move upon a graduated arc. This lever governs a valve which is placed in the pipe of communication between the boiler and the cylinder. This valve is so constructed that it may be opened or closed in a greater or less degree, so as to admit the steam to the cylinder in greater or less quantity, and thus regulate the motion of the engine.

The preceding description will be rendered more clearly and easily intelligible by reference to the annexed drawings, for the use of which we are indebted to the publishers of The Steam Engine, by the Artisan Club.

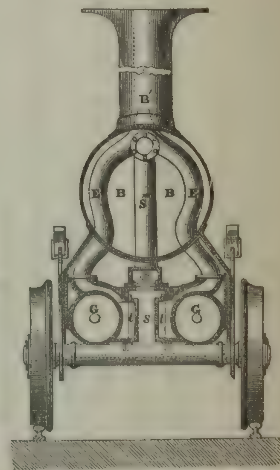
Fig. 1. represents the longitudinal section of a locomotive engine. The following are its parts:—*ss*, the piston-rods and cylinders; K, the excentrics; A′, the fire-box; A, the steam dome; S, S′, S″, S‴, the steam-pipe leading to the slides of the cylinders; B, the smoke-box; E, the blast-pipe; C, the tubes traversing the boiler; A″, the engine-driver's platform; *a′*, the grate bars; GG, the cylinder heads; QQ′, the way bar; *r*, the lever of the throttle valve, by which the engine-driver lets on and shuts off the steam, and governs the motion of the engine; *dd′*, the safety-valve.

Fig. 1.



LONGITUDINAL VERTICAL SECTION OF A LOCOMOTIVE ENGINE

Fig. 2.



ELEVATION OF THE HINDER END OF A LOCOMOTIVE ENGINE.

Fig. 2. is the end view of the engine, at the place where the engineer and fireman stand.

The several parts of the machine will be easily recognised from the preceding description.

The extraordinary speeds attained upon the railways, and the not less extraordinary loads which are transported at those speeds, will excite a natural curiosity to know the physical principles upon which such velocities can be imparted to such weights. It happens that these principles are extremely simple, and such as may be made perfectly intelligible to any commonly well-informed person. Let us take the case of an engine moved with a speed of 70 miles an hour, whose driving wheels are 7 feet in diameter, and consequently measuring about 21 feet, or 7 yards, in circumference; as a speed of 70 miles an hour is, in round numbers, 105 feet per second, it follows that, when moving at this rate, the driving wheels of the dimensions above mentioned would revolve at the rate of five times per second. Now, to produce one revolution of such wheels, each piston must once pass backwards and forwards in the cylinder, and its motion, therefore, must divide a second into ten equal parts. On arriving at each end of the cylinder, at the moment it is about to change the direction of its motion and to return, a valve must be shifted by which steam may be admitted at one side of the piston and withdrawn from the other side. This valve must, therefore, be moved ten times per second, and must complete its motion so rapidly as to form but a small fraction of the entire stroke of the piston, and therefore its motion must be computed by a small fraction of the tenth part of a second; and this must be done with the utmost punctuality and regularity, otherwise the action of the piston could not be continued. The cylinder discharges its contents through the escape valve every time the

piston changes its direction; and consequently this discharge must take place, under the circumstances here supposed, ten times per second.

But there are two cylinders, and the mechanism is so regulated that the discharge from the one is intermediate between two successive discharges of the other.

There are, therefore, 20 discharges of steam per second at equal intervals, and thus these 20 puffs divide a second into 20 equal parts, each puff having the twentieth of a second between it and that which precedes or follows it. The steam which thus puffs from the cylinder is conveyed by a pipe to the chimney, where it escapes upwards in a succession of blasts, by which the draught through the fire-place is maintained. It is these blasts of steam in the chimney which produce the coughing noise heard when a locomotive engine is moving slowly. As the rapidity augments these coughs become more rapid, and when the engine attains the speed which we have supposed above, there will be 20 coughs per second. The ear, like the eye, is limited in the rapidity of the sensations of which it is susceptible, and sensitive as that organ is, it is not capable of distinguishing sounds which succeed each other at intervals of the twentieth part of a second; therefore, when the engine moves at such a rate, the puffing in the chimney ceases to be appreciated by the ear, although, as a mechanical effect, it continues to be produced as accurately and regularly as when the engine is moving slowly.

According to the experiments of Dr. Hutton, it appeared that the time of flight of a cannon ball having a range of 6700 feet, is one quarter of a minute. The velocity is therefore 26,800 feet per minute, which is equal to five miles per minute, or 300 miles per hour. It follows, therefore, that a railway train moving at 75 miles an hour (not an uncom-

mon speed for express trains to attain), would have a velocity only four times less than a cannon ball. The momentum of such a mass moving at such a speed is difficult to conceive. It would amount to a force equivalent to the aggregate momentum of a number of cannon balls equal to one-fourth of its own weight. The consideration of the great damage done to the railway, as well as to the rolling stock, by these extreme speeds, is a serious drawback to the gratification which such wondrous performances naturally excite. The fracture and wear of rails is augmented in a very high ratio with the speed. So, likewise, is the wear of all parts of the vehicles most affected, such as wheels, axles, &c. We have shown that, at the speed we have here considered, a driving wheel seven feet in diameter revolves five times per second; but the bearing wheels of carriages, waggons, and vans are in general only three feet in diameter, and sometimes even less. Now, if a wheel of seven feet in diameter revolve five times per second, a wheel three feet in diameter proceeding at the same speed must revolve very nearly twelve times per second. This, therefore, is the action which must take place upon all the wheels of the vehicles composing each express train.

It will be asked by what means so enormous a rate of evaporation is produced and maintained as would be necessary to impart such a motion to the piston as is necessary to give the engine such a speed as is here mentioned? Since each piston must move once backwards and forwards in the cylinder for each revolution of the driving wheels, it is clear that in the case above described four cylinderfuls of steam would be consumed for each revolution of the driving wheels, and since these wheels revolve five times per second, 20 cylinderfuls of steam must be supplied by the boiler to the engine per second, or 1200 cylinderfuls per minute.

Now, if we suppose the volume of the cylinder to measure three cubic feet, it follows that the boiler must produce per minute, exclusive of waste, 3600 cubic feet of steam, which, at a pressure of 50 lbs. per square inch, would require the evaporation of above seven cubic feet of water per minute, or 420 cubic feet per hour, being the rate of evaporation of an ordinary stationary boiler of the nominal power of 420 horses. This great evaporating power is obtained principally by exposing a large heating surface to the action of the furnace, and partly by stimulating the furnace by great force of draught. The heating surface consists of — first, the surface of the fire-box, which is exposed to the direct action of the heat radiating from the fuel in combustion; and secondly, the surface of the tubes which traverse the boiler and by which the heated air is conducted from the fire-box to the smoke-box. These tubes are all below the level of the water in the boiler, as is also the entire heating surface of the fire-box. The tubes are so regulated in number and magnitude that when the heated air proceeding from the combustion has passed through them, and arrived at the smoke-box, it is reduced nearly to the temperature of the boiler, and is thus, as it were, strained of its heat.

A draught of intense power is maintained through the fire-box by discharging the steam which proceeds from the cylinders, after it has driven the pistons, through a pipe called the blast pipe, which is presented upwards in the chimney. Each successive cylinderful of steam, after it has driven the piston, escapes through a pipe of communication from the cylinder to the chimney, and rushes through this blast pipe with the coughing noise already mentioned, which is heard distinctly enough when the engine first begins to move.

The preceding observations are applicable generally to all the locomotive machines which will be found in the Exhibition. We shall now notice these engines individually.

The most conspicuous among them are three stupendous engines — two of which were exhibited by the North-Western, and the third by the Great Western Railway Company.

The North-Western Company exhibited a locomotive engine on a gigantic scale, called "the Liverpool," constructed by Messrs. Bury & Co. This vast machine is constructed on the principle of the Crampton patent, the peculiarity of which is, that the driving wheels are placed at the rear of the engine immediately under the fire-box. It is supported on eight wheels, the driving wheels being 8 feet, and the supporting wheels 4 feet in diameter. The cylinders are 18 inches diameter, and 24 inch stroke. The evaporating power of the boiler must be enormous, since the heating surface exposed to the direct action of the fire is 156 square feet, and the total surface of the tubes which traverse longitudinally the boiler, and by which the gaseous products of combustion are conducted from the fire-box to the chimney, and strained of their heat *en route*, have a total surface of not less than 2090 square feet. Thus there is a total heating surface of 2400 square feet. The weight of the machine when supplied with its full complement of coke and water is 37 tons.

The second engine exhibited by the North-Western Company is "the Cornwall," designed by M. F. Trevithick, one of the superintendents, and constructed at the Crewe establishment of that company in 1846, for the purpose of running express trains at a high rate of speed. The cylinders in this machine are 17½ inches in diameter, and 2 feet stroke. The driving wheels are 8 feet 6 inches in diameter. This increase of diameter is given to the driving wheels with a view to obtain an increased speed with a diminished wear, arising from too rapid reciprocation of the pistons.

The cylinders in this engine are placed outside the wheels.

The centre of gravity is lowered by suspending the boiler under the driving axle. The driving wheels are placed about midway in the length of the engine, while the others, bearing a less weight, are placed at the foremost and hinder ends; this disposition of the wheels being found to be favourable to the motion on curves. The boiler has 1046 feet of heating surface, with certain peculiarities of construction and arrangement of the working gear which render it easily examined when running. The gross weight of the engine in working trim is 27 tons. It is supported on eight wheels, and has taken trains at speeds varying from 60 to 70 miles an hour.

The Great Western Company exhibited a stupendous engine, constructed at their works at Swindon, called "the Lord of the Isles." This machine is one of the ordinary class of engines which have been worked for passenger traffic since 1847 by the Great Western Company. It is affirmed that it is capable of driving a train of 120 tons gross at an average speed of 60 miles an hour upon such gradients as those which prevail on the Great Western Railway, which, as is well known, is nearly level. The evaporating power of the boiler, when in full operation, is stated at 1000-horse power, and the effective power of the engine, measured by a dynanometer, is equal to 743 horses. Its weight, including coke and water, is 35 tons. The tender attached to this machine weighs 9 tons, the tank contains 1600 gallons of water, and there is space for a ton and a half of coke, giving a total weight, fuel and water included, of 17 tons 13 cwt. The surface in the fire-box exposed to radiant heat measures 156 square feet, and the heating surface of the tubes measures 1759 square feet. The diameter of the cylinder is 18 inches, the stroke 2 feet, and the diameter of the driving wheels 8 feet. It is estimated that the boiler is able to bear a pres-

sure of 120 lbs. per square inch, and that its actual consumption of fuel in practical work, drawing an average load of 90 tons at an average speed of 29 miles an hour, including stoppages (which represents a mail train), is under 21 lbs. of coke per mile.

Messrs. Hawthorn exhibited a locomotive engine of rather less dimensions, for which they claim a capability of running with safety at a speed of 80 miles an hour with a large express train. The cylinders are 16 inches in diameter, and 22 inch stroke; the driving wheels $6\frac{1}{2}$ feet in diameter, and the bearing wheels 39 inches; the heating surface of the fire-box is $98\frac{1}{2}$ square feet; the boiler is traversed by 158 brass tubes, giving a heating surface of 865 square feet. The principal improvements claimed by Messrs. Hawthorn for this machine are the following: — Instead of the six ordinary springs on each axle, the engine is fitted with double compensating beams and four springs, acting simultaneously on all the journals, by which the weight assigned to the respective axles is not affected by any irregularities or imperfections on the line of railway, but is uniformly maintained throughout, securing thereby a constant weight upon the driving wheels, and consequently a constant amount of adhesion. It is also claimed that by this direct, simultaneous connection between the axles, great stability is given to the engine, greater safety, particularly at high speed, and a smoother and easier motion. The engine has outside framing, with outside bearings to all the axles, the cylinders being placed inside. The engine is supported on six wheels, the driving wheels being in the centre. The second advantage claimed by the builders for this machine is the application of their expansive link motion and slide valves, which admit of the boiler being brought down nearly as low as in engines with straight axles, and that by the in-

troduction of the slide valves, the pressure on the valves, and consequently the friction, is considerably diminished. An arrangement is likewise introduced into the engine of the patent steam-pipe of Messrs. Hawthorn, which removes the domes and other projections on the top of the boiler. This steam-pipe is fixed into the tube plate of the smoke-box by a ferule like an ordinary tube, and extends nearly the entire length of the boiler. Being carried under the top, it is perforated with a series of small apertures or slits along its entire length, and is arranged so as to receive the steam directly above the place at which it is generated, instead of compelling it to rush from all parts of the boiler to one or two orifices. By this arrangement the steam is conducted to the cylinder, nearly, if not altogether, free from *priming*. The inside and outside framings extend the whole length of the engine, and are firmly tied together by strong iron double knee brackets.

Among the locomotive engines on a smaller scale, we noticed one called "Ariel's Girdle," exhibited by Messrs. Adams; a locomotive tank engine, exhibited by Messrs. Fairbairn; and one called "the England," exhibited by the engineer of that name. "Ariel's Girdle" is a four-wheeled engine, coupled to a four-wheeled carriage, constituting thus a complete eight-wheeled machine, adapted to run with great speed and safety for a distance of 50 or 60 miles without stopping. The carriage has accommodation for 8 first-class, 12 second-class, and 20 third-class passengers. This engine, with its attendant carriage, thus forming a train to accommodate 30 passengers, may also be advantageously worked as a mail or express train, or a train for branch lines. The inventor claims, also, that it is well adapted for highway purposes, with rails laid on the level of a macadamized road, which would not interfere with the ordinary traffic; thus

facilitating the construction of branch lines at a very cheap rate, by which railway communication might be carried into agricultural districts, and even into farm-yards. It is well known that in the United States such effects have been realised, the railways being, in many cases, carried through the streets of the principal towns. A railway is, for example, conducted through New York and terminates at the very centre of the city, near the park. Another is carried through the streets of Philadelphia, terminating in Market Street, and, in like manner, a line of railway is carried with facility through the streets of Baltimore, terminating near the harbour. In these cases the rails are laid flush with the road, a cavity being left on the inside of each rail, in which the flanges of the wheels play. It is not, however, customary in America to drive the locomotive engines through the streets. They are usually detached from the trains at a station in the suburbs, and the carriages are drawn by horses to the termini in the towns.

Mr. Adams claims that one of these engines, drawing one of the long eight-wheeled carriages, carrying 40 passengers, will travel with perfect smoothness and steadiness from 40 to 50 miles an hour, and, by reason of its lightness, will do this without any damage to the rails or roadway. It may be employed, also, as a simple four-wheeled tank engine, to draw 100 tons gross of waggons for a distance of 25 miles. A pair of ordinary breaks are applied to the driving wheels, and powerful sledge breaks are applied to the other wheels, the whole of which are at the command of the driver and stoker on the platform of the engine. This arrangement of sledge breaks prevents any damage to wheels or rails such as they are liable to with breaks of the common kind, and it is evident that so light a machine may be easily started and stopped. Engines of this form and construction have been

for some time in operation on the Eastern Counties, the Cork and Bandon, the St. Helen's, the Londonderry and Enniskillen, the Bristol and Exeter, and some other railways. They may be applied, according to the patentees, with advantage upon lines where the traffic is small, and where the larger class of engines is impracticable.

The second locomotive engine, of much smaller dimensions, called "the England," was remarkable for its great lightness in proportion to its power, and the combination of the engine and tender upon the same wheels. The purpose of this engine is to work trains of light weight, and its constructors affirm that it has sufficient power to impel a train of six first-class carriages at a speed of 60 miles an hour; and if their expectations be realised, it will accomplish this at half the working expense of the engines now used for such trains. Although it has no tender, it is stated to be capable of carrying a stock of fuel and water sufficient for a stage of 50 miles, so that it would be capable of taking a train from London to York by taking in a feed of fuel and water at three intermediate stations.

The South-Eastern Company exhibited an express locomotive engine called "Folkestone," constructed upon Mr. Crampton's patent, which claims advantages from having the engine suspended from three points at the ends of the machine, the object being to insure the weights on the wheels being at all times the same, and thus producing the greatest amount of steadiness. Attention is also claimed to the fact that the whole of the machinery is independent of the road, and is thus similar in its action to a fixed engine, and the risk of breaking the cranked axle, which frequently occurs in inside cylinder engines, is avoided.

Messrs. Fairbairn exhibited a locomotive tank engine, designed with a view to the economical working of a limited

passenger traffic. In order to diminish the dead weight, and obtain compactness, arrangements are made for carrying the supply of water and fuel upon the same frame which carries the engine. The total weight of the engine, including the tank, is thus reduced to 12 tons. The tank holds 400 gallons of water, with a corresponding supply of coke, and the engine will make a run of 35 miles without any further supply. The cylinders are 10 inches diameter, and 15 inch stroke; the driving wheels 5 feet diameter, the effective heating surface 415 square feet, which generates an ample supply of steam with a consumption of coke of 10 lbs. per mile.

In the following table we have shown, in juxtaposition, the principal dimensions of several of the machines above described:

		Liverpool.	Cornwall.	Lord of the Isles.	Haw-thorn.	Fairbairn's Engine.
Diameter of cylinder -	- inches	18	17½	18	16	10
Stroke of cylinder -	- —	24	24	24	22	15
Diameter of driving wheels	- ft., in.	8 0	8 6	8 0	6 6	5 0
Diameter of bearing wheels -	—	4 0	- -	- -	3 3	
Number of wheels -	- -	8	8			
Surface of fire-box exposed to radiant heat - -	- sq. feet	154	- -	156	98½	415
Heating surface of tube -	—	2,136	- -	1,759	865	
Weight of engine, including fuel and water -	- tons	37	27	35		
Weight of tender, including fuel and water -	tons, cwts.	- -	- -	17 13		
Quantity of water carried by tender - -	- gallons	- -	- -	1,600	- -	400
Quantity of fuel ditto -	- tons	- -	- -	1⅓		

One of the great disadvantages under which the management of the passenger traffic on the railways of the United Kingdom has hitherto laboured, is the disproportionate ratio of the dead weight to the profitable weight in the passenger carriages, as commonly constructed. Thus, first-class passenger carriages, which will weigh empty from 4 to 5 tons, will generally be incapable of transporting, when full, more than 18 passengers, without luggage. It is well known

that, in America, railway carriages are worked which transport 80 passengers, with very little more dead weight. An attempt is made to obviate this great waste of power in a new form of carriage, exhibited by the North-Western Railway Company. This vehicle, which was constructed at Wolverton, besides economising the dead weight, is also so constructed as to have greater durability and safety, in consequence of introducing the use of iron instead of wood into the framing and body of the carriage. The sheet iron which is used for the panelling is corrugated, which, while it increases the strength, gives greater external beauty to the outline and appearance of the vehicle. This carriage is supported by six wheels of peculiar construction, each wheel being formed of wrought iron in one solid piece, tire included, an arrangement which obviously gives greater security against fracture than the common mode of constructing the wheels in parts. The length of the carriage is 40 feet by 8 feet in width, and it is divided into two first class bodies, each capable of accommodating 8 passengers, and so lofty that a person of ordinary stature can stand erect with his hat on. There are 5 compartments, each of which accommodates 12 second class passengers, besides compartments of sufficient magnitude for the luggage of the passengers and accommodation of the guard. Thus, this carriage may be regarded as a train in itself, capable of conveying 76 passengers, with their luggage and guard, the total weight of the carriage, without its load, being only 8½ tons.

To convey the same number of passengers with the carriages at present used on railways would require a dead weight of from 17 to 18 tons. There are other features in this important vehicle which our limits render it impossible to explain. One of these is the contrivance for facilitating the motion of the carriage through curves. We may observe

here, however, that the obstructions and dangers commonly imputed to curves are greatly exaggerated, as every one knows who has travelled much on the American and some foreign railways, where sharp curves are passed over at great speed without either sensibly increased resistance or greater frequency of accident.

The South-Eastern Company exhibited a still larger passenger carriage. This vehicle is 44 feet in length, and has a floor of 374 square feet distributed over eight supporting wheels. It is built upon the principle of Adams's patent, and is arranged so as to be separable into two four-wheeled carriages, which, however, are so coupled that the combined bodies form a perfectly rigid frame. Notwithstanding its great length, provision is made to enable it to pass freely over curves of the smallest radius known on the English railways. This is accomplished by an arrangement which gives a lateral play of some inches to the wheels in their bearing, so that they can move right or left independently of the body of the carriage. By this plan each pair of wheels beneath the carriage is at liberty to follow the path of least friction by incessant lateral divergence, while the body of the carriage maintains perfect steadiness, whatever be the speed, by reason of its great length and width, precisely as a large steamer at sea is steady while a short one pitches. The load, also, being distributed uniformly over eight springs, and not subject to oscillation, the springs are not liable to be broken by sudden shocks, and may be made more light and flexible. The advantage claimed for this species of passenger vehicle, a considerable number of which are in process of construction for the South-Eastern Company, are, first, economy in tractive power by diminished friction; secondly, economy in structure by a diminution of the ratio of the dead to the profitable weight; thirdly,

freedom from oscillation; fourthly, greater safety in case of collision. The woodwork, as well as the wheels, is constructed of varnished teak timber, similar to that used in Dutch shipping. The body of the vehicle consists of four first class and four second class compartments, with a compartment for the guard and luggage. There is thus accommodation for 80 passengers. The bodies are so contrived that they are capable of being uncoupled, so that the second class may be separated from the first class, thus resolving the carriage into a four-wheeled first class and a four-wheeled second class carriage.

It is remarkable that among these attempts to obtain economy in the structure of railway passenger carriages no attempt is visible — at least among the carriages which appeared in the Exhibition — to introduce the system of passenger carriages so universally and successfully adopted in the United States, and which would appear to be advantageously applicable here — at least for the purpose of second class vehicles forming parts of trains where express speeds are not attempted. The American railway carriage consists of a large body like that of a London omnibus, but much wider, and twice or thrice the length. The doors of exit and entrance are at each end, a line of windows being placed at each side similar to those of an omnibus. Along the centre of this species of caravan is an alley, or passage, just wide enough to allow one person to walk from end to end. On either side of this alley are seats for the passengers extending crossways. Each seat accommodates two persons, four sitting in each row, two at each side of the alley. There are from 15 to 20 of these seats, so that the carriage accommodates from 60 to 80 passengers. In cold weather, a small stove is placed near the centre of the carriage, the smoke pipe of which passes out through the roof, and a good lamp

is placed at each end for illumination during the night. The vehicle is perfectly lighted and warmed. The seats are cushioned, and their backs, consisting of a simple padded board, about six inches broad, are so supported that the passenger may at his pleasure turn them either way, so as to turn his face or his back to the engine. For the convenience of ladies who travel unaccompanied by gentlemen, or who otherwise desire to be apart, a small room, appropriately furnished, is sometimes attached at the end of the carriage, admission to which is forbidden to gentlemen.

It will occur at once to the engineer that vehicles of such extraordinary length would require a railway absolutely straight; that it would be impossible to move them through any portion of a line which has sensible curvation. Curves altogether inadmissible on any European line, are, nevertheless, admitted in the construction of American railways without difficulty or hesitation, and through these the vehicles just described move with the utmost facility. This is accomplished by a simple and effectual arrangement; each end of this oblong caravan is supported on a small four-wheeled railway truck, on which it rests on a pivot, exactly similar to the expedient by which the fore wheels of a carriage sustain the perch. These railway carriages have, in fact, two perches, one at each end; but instead of resting on two wheels, each of them rests on four. The vehicle has, therefore, the facility of changing the directions of its motion at each end, and in moving through a curve one of the trucks will be in one part of the curve while the other is at another, the length of the body of the carriage forming the cord of the intermediate arc. For the purposes they are designed to answer these carriages present many advantages. The simplicity of the structure renders the expense of their construction incomparably less than that of any class of carriages on an European railway; but a still

greater source of saving is apparent in their operation. The proportion of the dead weight to the profitable load is far less than in the first or second class carriages, or even than the third class, on the English railways. It is quite true that these carriages do not offer to the wealthy traveller all the luxurious accommodation which he finds in our best first class carriages, but they afford every necessary convenience and comfort.

In several of the principal American cities, the railways are continued to the very centre of the town, following the windings of the streets, and turning without difficulty the sharpest corners. The locomotive station is, however, always in the suburbs. Having arrived there, the engine is detached from the train, and horses are yoked to the carriages, by which they are drawn to the passenger depôt, usually established at some central situation. Four horses are attached to each of these oblong carriages. The sharp curves at corners of the streets are turned by causing the outer wheels of the trucks to run upon their flanges, so that they become, while passing round the curve, virtually larger wheels than the inner ones. We have seen, by this means, the largest railway carriages enter the depôts in Philadelphia, Baltimore, and New York, with as much precision and facility as was exhibited by the coaches that used to enter the gateway of the Golden Cross or the Saracen's Head.

The North-Western Company exhibited two specimens of goods waggons on improved principles, constructed under a patent obtained by Mr. Henson. One of these waggons, which appeared in the Exhibition, is made of hard mahogany, with sliding doors on one side, and a sliding roof for about half the breadth of the waggon, and about one-third of its length, corresponding to the opening of the doors on the side, for the purpose of facilitating the loading and unloading.

The sliding doors and roof are secured by means of a peculiar fastening, which locks the doors and roof at the same time, without a key; but the doors cannot be opened without the proper key. This waggon weighs about four tons and a half, and is capable of holding six tons of goods, forming, when closed, a kind of fire and water proof warehouse, and, at the same time, preserving the goods from thieves.

The other waggon differs from this in construction to some extent, being made wider, but with similar framework, and instead of having wooden panels, corrugated sheet iron is used for that purpose, which is fitted exactly in the rounds and hollows to the framework inside, and secured thereto by screws, thus forming a comparatively light and very strong body. This waggon weighs about 4 tons, 2 cwt., and is capable of conveying 10 tons of goods, thus saving a considerable amount of dead weight. From its superior construction there is every probability that it will last for a much longer period without requiring repair than the ordinary goods waggon.

There is also a model of Henson's improved goods waggon made to a scale of two inches to the foot. This model is of beautiful workmanship, and includes the latest improvements of the inventor. The framework is lined or panelled with corrugated sheet iron of superior quality, which is covered on both sides with a thin coating of glass which completely protects the surface of the iron from the weather, and adheres so closely to it that severe blows will not break or remove it.

This process of glazing the surface of iron appears to be a valuable discovery, not only for this purpose, but for many others, particularly as the expense is said not to be greater than galvanizing, while it is believed to be much more durable, and never likely to require painting. The roof of this model is covered with glazed corrugated iron, of the same

description as that forming the panels on the sides and ends of the waggon.

These waggons are, in fact, movable warehouses.

Besides the engines and vehicles of railway transport, a great variety of improved arrangements in railway mechanism of a miscellaneous kind appeared in the Exhibition, many of which are well worthy of attention, and we have only to regret that our limits compel us to pass without notice many of these interesting and useful inventions and contrivances.

Mr. J. C. Haddon exhibited specimens of patent papier maché for the panelling of railway carriages. This panelling is recommended for cheapness and durability. The paper panels will not shrink, and present no grooves to retain water, which rots the framing.

Mr. D. Harvey exhibited a patent contrivance, by which the locomotive may be disconnected from the train whenever it accidentally escapes from the rails.

Mr. H. Pooley exhibited a weighing machine, by which the gross weight, and also the pressure of each separate wheel, of a locomotive can be at once ascertained. Its use is to enable the superintendent engineer to adjust the springs of the engine so as to obtain the proper amount of tractive power which is consistent with safety from tendency to run off the line at curves.

Messrs. Sanford and Watson, of Rotherham, exhibited railway wheels, three feet in diameter, of wrought iron, and welded into one piece. The manufacture is effected by machinery, and they are not much more expensive than the common wheel.

Mr. H. Smith, of West Bromwich, near Birmingham, also exhibited solid wrought iron railway wheels forged in a single piece, including the tire and nave, made of various diameters,

and adapted for the leading and trailing wheels of engines and tenders, as well as for carriages and waggons.

Mr. R. Jeffrey, of Gray's Inn, exhibited a railway tunnel signal, intended to prevent accidents to a train while in a tunnel from being overtaken by another train. By this contrivance a large white disk is displayed by day and a lamp by night, at the upper end of the tunnel immediately on the train entering, and continues to be displayed until the train issues at the other end of the tunnel, when it instantly disappears. This is repeated whenever a train enters or quits a tunnel, and the signal appears and disappears by self-acting machinery.

Nothing can more strikingly manifest the progress which has been made in the art of locomotion since the opening of the Liverpool and Manchester Railway—an interval of scarcely more than twenty years—than a comparison of the railway mechanism at such epoch with the railway mechanism as it exists at present, and a retrospect of the progress it has undergone in that interval.

The first rails laid down on the Liverpool and Manchester Railway had a form called fish-bellied—now out of use—and weighed 35 lbs. per yard. The strength of these was, at the time, considered great to superfluity, and the form was regarded as eminently favourable to their durability. Experience, however, soon proved their weight to be utterly insufficient, and their form to be a source of weakness.

The weight of the rails now laid down on many of the railways which carry the greatest traffic amounts to from 80 lbs. to 90 lbs. per yard.

The changes which have been applied in the form and weight of the rails laid down upon the railways, showing the varieties of their section and weight, were illustrated in the Exhibition by an interesting collection of specimens, and

some remarkable rails are exhibited rolled in single pieces of extraordinary length.

It may not be uninteresting here briefly to explain the manner in which these prodigious railway bars are fabricated. The iron, being softened by heat in large masses, is first reduced under the hammer into pieces of a certain length. These are successively placed between iron rollers, the surfaces of which are cut to the form intended to be given to the rails. The incandescent iron, having the softness of wax, and being introduced at one end between these rollers, is drawn through them and reduced by their pressure to the desired form.

The first engine placed upon the Liverpool and Manchester Railway weighed, with its tender, 7½ tons. There are now several engines which, with their tenders, exceed 60 tons, and at the beginning of last year there were in the service of a single company not less than 36 engines, having the average weight, tenders included, of 40 tons.

The carriages have undergone a corresponding increase. The first carriage placed upon the railways weighed about three tons; some of those now in use are very little short of double that weight.

The quantity of the traffic and the speed of the trains since the opening of the railways has gradually increased far beyond any limit which had entered into the contemplation of the engineers who projected and constructed these lines of communication. Thus, in 1831, the average speed of the railway passenger trains was 17 miles an hour; it was gradually increased until, in 1848, it attained 30 miles an hour. The speed of the fast trains, in 1831, on the London and Manchester Railway, was 24 miles an hour; in 1848 their average speed on the Grand Junction and London and Birmingham was 50 miles an hour.

In 1831 the number of trains per day which arrived at and departed from the Stafford station on the Grand Junction line was 14; in 1848 it was 38.

The number of trains per day which arrived at and departed from the Euston Square station of the Birmingham line in 1837 was 19; in 1848 it was 44; and, at present, the number is still greater. In 1831 the number of trains arriving at and departing from the Liverpool terminus was 26; in 1848 it was 90; and is now above 100.

A corresponding increase has taken place in the weight of the trains. In 1831 the average weight of a passenger train, tender and engine included, was 18 tons; in 1848 the average weight of the engine and tender alone was considerably above 20 tons, and the average weight of the passenger trains, engine and tender excluded, 75 tons. In 1831 the average weight of a goods' train, tender and engine included, was 52 tons; in 1848 it was about 170 tons.

Thus the number of trains for some of the principal railways has increased 150, on others 250, per cent; the weight of the engines has been increased 114 per cent, the weight of the carriages 30 per cent, the average speed 90 per cent, and the average weight of the trains 350 per cent.*

The road structure has undergone corresponding changes. The mode originally adopted for supporting the rails was upon square blocks of stone measuring two feet in the side and one foot in depth, upon which a cast iron chair was fastened with wooden pegs driven into holes bored in the stone block, the rail being fixed in the chair by an iron pin. These blocks were then supported by transverse beams of wood called sleepers, which served at once as a support and a tie to the rails. The timber composing these sleepers

* Lardner's Railway Economy, chap. iv.

being found perishable, its durability was augmented by impregnating it with certain saline substances, by which soft wood became as durable as oak; but it is now proposed to lay aside this foundation of timber and to substitute for it a complete cast iron framing.

A model of a railway constructed on such a principle was exhibited by Mr. P. W. Barlow, the well-known engineer. This improved rail has been laid on a portion of the South-Eastern line. He also exhibited models of supports for points and switches. The novelty of the rail consists in casting the chair upon a cast iron plate, which supplies the place of a wooden sleeper or a stone block. The advantage claimed for this system over the common method of constructing railways is greater durability and an increased number of chairs or points of support, which, being planed true to line and level, afford a means of obtaining greater accuracy in the construction of the road.

A great variety of contrivances were presented in the Exhibition, the object of which is to give increased security to railway travelling, by providing against the effects of collision and other casualties.

Mr. E. Cheshire exhibited a contrivance for lessening the danger of collision on railways. This object is proposed to be attained by suspending under the centre of every carriage a strong iron rod, or tube, with an expanding head at each end, called a "safety buffer," and moving, when acted upon, in a longitudinal direction; and also by attaching at the hinder end of the train a strong van with a low centre of gravity, for the purpose of receiving the first shock of a collision, should it take place from behind: the tender being made to answer a similar purpose should the collision occur at the front. The force of the shock will throw the "safety buffers" into one continuous inflexible rod, by means of

which its force will be transmitted to the opposite end, so as to protect the intermediate carriages.

Mr. W. N. Crips exhibited a model locomotive tender and carriage for reducing the danger of collision on railways, and for affording refuge to the engine driver and stoker. The novelty of the invention consists in the construction of a carriage with longitudinal tubular beams and rods, in lieu of the solid timber or iron beams at present used, and in the arrangement of elliptical springs, forming together an expanding and collapsing carriage, capable of sustaining an immense shock without receiving injury. Any description of body may be placed on the carriage, and a portion of the arrangement of springs is so designed as to be capable of being adapted to the form of every carriage in present use. It is considered that a train so fitted would suffer but little injury from shocks from front or rear.

M. C. Chabot exhibited models of three railway carriages, showing the application of a self-acting break, by means of which a train in motion can be stopped without shock and without wear and tear of the wheels or rails. The breaking power is communicated to each carriage in succession through the train. He also exhibited the application of locked buffers, by means of which oscillation is diminished and the concussion occasioned by collision received upon the line of buffer rods, instead of being spent upon the carriage frames.

Mr. W. Hattersley exhibited a contrivance to enable passengers to communicate at all times with the drivers and guards. This contrivance consists of a cylindrical tube or casing to be fixed to the top or side of each carriage. Within the casing is placed a lamp, which is secured by a spring lock, and remains concealed until it is desired to give the signal; when, upon drawing a bell-pull placed in the carriage, the spring lock is withdrawn, the lamp fixed

up, and the signal given. This is equally available by night and by day.

Mr. George Gray, of Birmingham, exhibited a guard's van with a break of great force and intense effect, having a direct communication between the guard and the engine, and acting on the road when it has a surface of friction of fifteen feet, that of the common breaks having only four inches. The inventor claims that this break will stop a train within one quarter of the distance required at present.

Although these expedients, having for their object the increased safety of railway travelling, are entitled to all praise and encouragement, the great source of security to the railway traveller must depend on the managers of the railways themselves. While, however, no exertion should be spared to stimulate the directors of railways to a proper vigilance, it is right that the public fears should not be exaggerated, and that the real amount of risk in railway travelling should be known.

The official return made annually by the Railway Commissioners of the number of accidents which occur upon the railways and their causes, and also of the quantity of traffic in passengers and goods carried upon them in the same time, supplies the means of ascertaining the actual chance of accidents to which each railway passenger is exposed.

It is not enough, however, to compare, as is commonly done, the number of accidents with the total number of passengers booked, for it is easy to show that such a comparison does not afford a true measure of the risk. By adopting such a measure, it would be inferred that a passenger who travels 10 miles is exposed to as much risk as one who travels 500; an obvious error. The risk of accident to each passenger is, *ceteris paribus*, in the exact proportion of the distance he travels. To calculate the risk,

therefore, it is only necessary to compare the number of accidents with the mileage of the passengers booked. Such a comparison has been made*, and the result of it shows that when a passenger travels 1 mile on a railway the chances against his encountering an accident fatal to life are 65,363,735 to 1, and that the chances against his encountering an accident producing personal injury, even of the slightest kind, are 8,512,486 to 1.

Of course, the chances of accident of either kind will be augmented in the exact proportion of the distance travelled. Thus, if a traveller go 100 miles, the chances against his suffering an accident fatal to life are 653,637 to 1, and the chances against an accident productive of mere bodily injury are 85,125 to 1.

It must be observed here that this calculation applies only to accidents arising from causes beyond the control of the passenger himself. The causes of accident which are independent of the passenger are generally through collision or the escape of the train, or some part of it, from the rails.

Since all trains moving in the same direction travel on the same line of rails, it is evident that, if the trains moved at the same speed and all stopped at the same stations, no collision could ever take place, except when a train should be retarded or stopped by accident, or in the case of a vehicle being improperly left standing on the line. The probability of a collision will, therefore, depend on the difference between the speeds with which several trains travel, and the difference between the number of stations at which they stop.

But on railways, as worked at present, it is impossible to maintain that uniformity which would remove this risk of collision. Passengers and goods being worked upon the same

* Lardner's Railway Economy, chap. xiv.

line of rails, and the latter being carried at a less speed than the former, a serious source of danger is produced. If the present enormous amount of transport had been foreseen when railways were in an early stage of their progress, it might have been a question for consideration whether it would not have been advantageous to construct the trunk railways at least, with three lines of rails instead of two, reserving an exclusive one for the goods traffic and the third class passenger trains which stop at all the stations. But the railways being now constructed, it is too late, and nothing remains to be done but to adopt the most efficient protection against these collisions, the probability of which is augmented with the frequency of the trains and the difference of their various speeds.

The accommodation of the public requires frequent departure, great expedition, and means of arriving at numerous intermediate stations on the line; and these demands cannot be satisfied without the calling into existence all the conditions which are productive of danger of collision.*

It appears from an analysis of the returns of accidents made by the Railway Commissioners, that in every 100 accidents the following is the proportion of the causes which produce them: —

Accidents from	collision	56
„	broken wheel or axle	18
„	defective rail	14
„	switches	5
„	impediments lying on road	3
„	off rails by cattle on line	3
„	bursting boiler	1
		100

* Lardner's Railway Economy, p. 319.

It appears from this table that 56 per cent of all the accidents arise from collision; next to this comes escape from the rails by the breaking of a wheel or axle, and by defective rails, which make up 32 per cent, the remaining causes making up but a small proportion.

Many of the railway accidents which are recorded arise from the imprudence and the rashness of the passengers themselves, by far the most frequent causes of such accidents being the getting into or out of the train while in motion, and sitting or standing in an improper place, attitude, or position.

The following analysis of the accidents occurring on railways from causes which may be avoided by proper care on the part of the passenger is taken from the work on Railway Economy already quoted: —

ANALYSIS OF 100 ACCIDENTS PRODUCED BY IMPRUDENCE OF PASSENGERS.

	Killed.	Injured.	Total.
Sitting or standing in improper positions -	17	11	28
Getting off when train in motion - -	17	7	24
Getting up on train in motion - -	10	6	16
Jumping off to recover hat or parcel -	8	5	13
Crossing the line incautiously - -	11	1	12
Getting out on wrong side - - -	3	3	6
Handing an article into train in motion -	1	0	1
Total - - - -	67	33	100

The incautious railway passenger may derive a salutary lesson from this table. He will see from it that two-thirds of the accidents resulting from imprudence are fatal to life, and that nearly seven of every ten of such accidents arise from sitting or standing in an improper or unusual place or position, or from getting on or off a train while in motion.

This latter circumstance should be most carefully guarded against, for it is a peculiarity of railway locomotion that the speed when not very rapid always appears to an unpractised passenger to be much less than it is. A railway train moving at the rate of a fast stage coach seems to go scarcely as fast as a person might walk.

V.

THE RAILWAYS OF THE UNITED KINGDOM.

Having explained in our notice of Railway Machinery the improvements which have been effected in the mechanism of transport, and the means whereby such vast powers of locomotion have been created, we shall now briefly state some of the most striking effects which have resulted from the practical application of these powers within the territory of the United Kingdom.

As the actual quantity of locomotion executed by the moving power depends conjointly, in passenger traffic, on the number of passengers, and the distances they are transported, and in goods traffic on the number of tons, and the distances they are carried, it has been found convenient to reduce the expression of the quantity of traffic of each kind to the equivalent number of units carried one mile. Thus 2 passengers travelling 10 miles, or 10 passengers travelling 2 miles, are represented indifferently by 20 travelling a mile.

The following table, computed on this principle, exhibits, in the second column, the number of passengers transported one mile, to which the entire average daily passenger traffic is equivalent. These numbers, being divided by the average

number of passengers booked, give the average distances travelled by each passenger, which appear in the fourth column: —

Year.	Average daily Mileage.	Average Number of Passengers booked.	Average Distance travelled by each Passenger.
			Miles.
1846	2,184,300	119,975	18·22
1847	2,205,494	139,440	15·74
1848	2,484,944	159,134	15·65
1849	2,978,635	194,854	15·30
1850	3,290,864	228,265	14·41

The results of this table, so far as regards the distance travelled per passenger, will, no doubt, be unexpected.

Few would have supposed that the bulk of the passengers made such short trips. It appears from calculations, for the details of which we have not space, that the average distance travelled by the first-class passengers is 27 miles; that of the second class, 16½; and that of the third class, 14 miles.* It is evident from this, that short traffic constitutes the staple of the railway passenger business.

From the above table, it appears that the amount of passenger traffic daily executed upon the railways was augmented in the ratio of 218 to 329 in the five years ending 31st Dec. 1850. But in that interval the length of railways under traffic was augmented in a much higher ratio.

At the middle of 1846 the total length of railways under draught was 2500 miles, while at the middle of 1850 it was 6300 miles. While, therefore, the length of railway under traffic was augmented in the ratio of nearly three to one, the passenger traffic was augmented only in the ratio of three to two. The traffic did not increase half as fast as the railway.

We find a very curious and interesting computation in the

* Lardner's Railway Economy, p. 168.

work already quoted, showing what would be the amount of horse power necessary to execute, on common roads, this prodigious locomotive service, and what is the amount saved to the public by the substitution of the locomotive engine and the railway for the stage coach and common road, supposing that such an amount of transport on common roads were practicable.

The experience of stage coach proprietors in business conducted on a large scale establishes the general fact that a fast coach travelling between any two distant places both ways daily requires to work it as many horses as there are miles. The average load of such a coach is found to be about two-thirds of what it is capable of carrying. Thus, supposing it to be capable of carrying 15 persons inside and out, its average load would be 10.

These 10 passengers would be carried both ways one mile per day per horse. The daily locomotive service of a horse thus working is therefore represented by 20 passengers carried one mile.

If we would then ascertain the number of horses which would be necessary to execute the service of the railways, it is only necessary to divide their daily mileage by 20; the quotient will be the number of horses required.

Let us take, for example, the six months ending December 31. 1848. The daily mileage of the passengers generally during these six months was 2,866,682. This divided by 20 gives 143,334, which would therefore be the number of horses working daily in stage coaches which would execute the passenger traffic of the railways that took place during this half-year.

It is worth while to compare the cost at which this amount of public service has been performed with that at which it would have been effected by stage coaches. In making such

a comparison, it must be observed that railway transport presents three sources of relative economy — first, the saving of fare; secondly, the saving of time; and thirdly, the saving of tavern expenses on the road.

Before the establishment of railways on their present scale, the average fares of mail and stage coaches, including the allowance to guards and coachmen, which are not chargeable to railway passengers, were as follow: —

	Per 100 miles.	
	s.	*d.*
Mail (inside) - - - -	52	0
„ (outside) - - - -	30	0
Fast coach (inside) - - -	48	0
„ (outside) - - -	26	0

The average railway fares for the same distance at present would be as follow: —

	Per 100 miles.	
	s.	*d.*
Per mail, express, and first-class trains, corresponding with inside coach places - -	20	0
For second and third class - - -	11	0

Hence it follows that for every 100 miles travelled by first class passengers there is a saving in the fare amounting to 30*s.*, and for every passenger of the inferior classes there is a saving amounting to 17*s.*

The stage coaches would travel, stoppages included, at 7½ miles an hour, and consequently would require 13 hours 20 minutes to travel 100 miles. This distance would be travelled on the railway by slow passenger trains in less than five hours, by the faster trains in three hours, and by express trains in a still less time. But let us take it at four hours;

then there will be 9 hours and 20 minutes' time saved to each passenger on 100 miles trip. Now, if we take the value of the time of the class who travel at the average value of 6*s.* per working day of 12 hours, this will be 6*d.* an hour, which will make a saving of 4*s.* 8*d.* for every 100 miles travelled.

Finally, every traveller who is detained long upon the road must resort to taverns for refreshment. If he be 13 hours on the road he will at least take one meal; many will take two. A traveller, however, who is detained only three or four hours on the road will take none. Let us put down the cost thus incurred at 6*d.* per 100 miles for each passenger — a very low estimate; we shall then have the following account of the amount saved to the public in the two years ending June 30. 1848, by the railways in passenger traffic as compared with stage coaches, supposing that such an amount of traffic by such means was practicable:—

Fares saved by 354,083,534 first-class passengers, carried one mile, at 3½*d.* per head - -	£5,163,718
Ditto by 1,357,936,966 second and third class passengers, carried one mile, at 2*d.* per head -	11,316,141
Value of time saved by 1,712,020 passengers travelling 100 miles, at 4*s.* 8*d.* per head - -	399,417
Tavern expenses on 1,712,020 passengers travelling 100 miles, at 6*d.* a head - - -	42,800
Total saving in the two years ending June 30. 1848 - -	£16,922,076

It would be an interesting point in railway statistics to determine the amount of locomotive power actually employed on the English railways, and the fuel consumed in working it. By a calculation, the details of which are given in the work already quoted, it appears that in the 12 months ending June 30. 1849, when there were 5000 miles of railway under

traffic, the number of locomotive engines in operation was 1965. The total distance run by these within the year was 32,388,589 miles, giving a daily average of 88,736 miles. By the returns of the consumption of fuel made by the Great Western and the North Western and other principal lines, it was found that the average consumption of coke per mile at that epoch was 35 lbs., from which it would follow that the total amount of coke consumed within the year was 506,071 tons. But 10 tons of coal are required to make seven tons of coke, consequently the number of tons of coal consumed in locomotives on railways in the 12 months ending June 30. 1849, was about three quarters of a million.*

The Great Western Railway Company now affirms that the average consumption of fuel in the practical working of such an engine as "The Lord of the Isles," exhibited by them, would, with an average load of 90 tons and an average speed of 29 miles an hour, including stoppages, be only 20·8 lbs. per mile.

We cannot, however, reconcile this estimate either with our own observations or with the published reports of the Great Western Railway Company themselves. We have not before us, it is true, any reports of that company more recent than those for the year 1848; but it appears by these, that in the four years ending 1848, the total consumption of coke on their lines, compared with the mileage of their engines, was as follows:—

Year.	Coke consumed.	Mileage of Engines.	Coke consumed per Engine per Mile.
	Tons.		lbs.
1845 - -	21,919	1,240,412	39½
1846 - -	19,731	1,346,341	33
1847 - -	21,454	1,454,610	33
1848 - -	25,346	1,582,672	35 8·10

* Lardner's Railway Economy, pp. 82, 83.

These results are further confirmed by the official returns of the North-Western Railway Company, by which it appears that in the 12 months ending the 30th of June, 1849, their total consumption of coke was 116,396 tons, while the total mileage of their engines was 7,535,230, which gives an average consumption of 34·6 lbs.

It must be understood, however, that in this estimate was included all the fuel consumed, not only while the engines are actually in motion, but all they consumed in getting up the steam and when they are standing lighted without working.

Unless, therefore, in the two years which have elapsed since the date of the above reports, a reduction has taken place in the consumption of fuel by the Great Western Company to the almost incredible amount of 43 per cent., it would appear that there must be some error in the present estimate.

Assuming, as we may do with sufficient accuracy, that the amount of locomotive power and the consumption of fuel employed on the railways is in the direct ratio of their gross receipts, we shall obtain a tolerably accurate estimate of the present locomotive power and consumption of fuel by comparing the receipts of the past years with those of 1848.

In the last six months of 1848 the gross receipts upon the railways amounted to 5,744,965*l.*, while in the last six months of 1850 their amount was 7,147,378*l.* If we assume that the increase of locomotive power and the consumption of fuel have been in the proportion of these numbers, we shall obtain the following estimate of the total number of locomotive engines now working on the railways of the United Kingdom, and their consumption of fuel: —

Number of engines working on the railways in 1850		2,436
Quantity of coke consumed by them within the year - - - - -	(tons)	627,528
Quantity of coal consumed - -	„	896,466
Total distance run within the year -	(miles)	40,161,850
Average distance run per day - -	„	110,333

It must be admitted that these results are somewhat stupendous. It appears that in the performance of the work of inland communication in these islands the locomotive engine travels daily over a space nearly four and a half times the circumference of the globe, and that within the year it travels over a space nearly one half the distance between the earth and the sun.

It appears, further, that in executing this traffic a quantity of coal is used which, if formed into a pillar having the base of a square yard, would reach a height of 757 miles.

It would be extremely interesting, if correct data could be obtained for the purpose, to ascertain the proportion in which goods and passengers contribute to the revenue of railways. Until the year 1847 the Railway Commissioners published, annually, reports of traffic, containing some useful data of this kind; but since that year these reports have been limited to a general summary of the traffic, which for statistical purposes is nearly useless.

The following table has been calculated from the returns of 1847, showing the proportion of the gross revenue of the railways which proceeded from the different objects of traffic.*

* Lardner's Railway Economy, p. 278.

	Receipts.	Per Cent of Total Receipts.
	£	
Passengers, 1st class - - -	1,725,759	20·3
" 2d class - - -	2,098,080	24·6
" 3d class - - -	1,324,163	15·5
Merchandize - - - -	2,606,393	30·8
Cattle - - - - -	71,482	0·8
Sheep - - - - -	53,091	0·6
Pigs - - - - -	23,718	0·3
Horses - - - - -	78,549	0·9
Private carriages - - - -	52,521	0·6
Baggage, parcels, and mails - -	377,290	4·4
Sundries not classed - - -	99,840	1·2
Grand total - - -	8,510,886	100·0

It appears, therefore, that at this epoch the passenger traffic supplied 60 per cent of the gross revenue, and the goods traffic 31 per cent, the remainder arising from baggage, parcels, and sundries.

It appears, from the official returns lately published, that the proportion of the revenue of the railways arising from merchandize has been gradually increasing.

In the following table we have given the receipts of the last six months of each of the three years ending with 1850: —

	Total Receipts from Passengers.	Goods, &c.	Total.	Per Cent of Total Receipts by Passengers.	Per Cent of Total Receipts by Goods, &c.
	£	£	£		
1848	3,283,302	2,461,663	5,744,965	57·40	42·60
1849	3,455,217	2,895,243	6,350,460	54·40	45·60
1850	3,817,403	3,329,975	7,147,738	53·43	46·57

On comparing the gross revenue produced by the railways of the United Kingdom with the total length of lines under traffic, it will be apparent that the increase of traffic has proceeded in a much less ratio than the extent of the railways. In the following table we have given, in the first column, the

average length of railways under traffic in each of the same years, and in the second column we have given the gross receipts of the last six months of each year :—

	Railways under Traffic.	Receipts.	Increased per Centage of Railways open.	Increased per Centage of Receipts.
1848	5,007	5,744,965		
1849	5,740	6,350,460	14·6	10·5
1850	6,464	7,147,378	25·4	12·5

It appears, therefore, from these results, that while the railways were increased in length 14·6 per cent in 1849, as compared with 1848, and 25·4 per cent in 1850, as compared with 1849, the revenue proceeding from them was increased only 10·5 per cent in 1849, as compared with 1848, and only 12·5 in 1850, as compared with 1849.

The working expenses of railways are of course subject to considerable variation, in some being 60 or 70 per cent of the receipts, while in others they do not exceed from 35 to 40. As we have official returns of the gross receipts of the railways, as well as the capital invested in them, if we possessed corresponding returns of their working expenses we should be enabled to ascertain the net profits on the capital involved. In the absence of correct data we may, however, approximate to this interesting result.

If we take the working expenses at 40 per cent of the receipts — and they certainly are not under that — the major limit of the profits from year to year during the seven years ending 31st December, 1848, will be obtained as follows *: —

* Lardner's Railway Economy, p. 307.

	Length of Railway open.	Capital expended.	Total Receipts.	Per Cent on Capital.		
				Receipts.	Minor Limit of Expenses.	Major Limit of Profits.
Twelve months ending—	Miles.	£	£			
June 30. 1843 - -	1857	74,280,000	4,535,189	6·1	2·4	3·7
" 1844 - -	1952	78,080,000	5,074,674	6·5	2·6	3·9
" 1845 - -	2148	85,920,000	6,209,714	7·2	2·9	4·3
" 1846 - -	2441	97,640,000	7,565,569	7·8	3·1	4·7
" 1847 - -	3036	121,440,000	8,510,886	7·0	2·8	4·2
" 1848 - -	3816	152,640,000	9,933,552	6·5	2·6	3·9
Six months ending—						
Dec. 31. 1848 - -	5079	205,160,000	5,744,965	5·6	2·2	3·4

Since the above dates we have no data for the amount of capital expended, and therefore cannot extend these calculations to a more recent period.

VI.

LOCOMOTION BY RIVER AND RAILWAY IN THE UNITED STATES.

England has been so dazzled by the splendour of her own achievements in the creation of a new art of transport by land and water within the last thirty years, as to become in a measure insensible to all that has been accomplished in the same interval and in the same department of the arts elsewhere; improvements less brilliant, indeed, intrinsically, than the stupendous system of inland transport which we have noticed, and having a lustre mitigated to our view by distance, yet presenting in many respects circumstances and conditions which may well excite profound and general interest, and even challenge a respectful comparison with the greatest of those advances in the art of locomotion of which we are most justly proud.

It will not, therefore, be without utility and interest, after the detailed notice which we have given of our own advances in the adaptation of steam to locomotion, to direct attention to the progress in the same department which has been simultaneously made in other and distant countries, and first, and above all, by our friends and countrymen in the other hemisphere.

The inland transport of the United States is distributed mainly between the rivers, the canals, and the railways, a comparatively small fraction of it being executed on common

roads. Provided with a system of natural water communication on a scale of magnitude without any parallel in the world, it might have been expected that the "sparse" population of this recently settled country might have continued for a long period of time satisfied with such an apparatus of transport. It is, however, the character of man, but above all of the Anglo-Saxon man, never to rest satisfied with the gifts of nature, however munificent they be, until he has rendered them ten times more fruitful by the application of his skill and industry; and we find accordingly that the population of America has not only made the prodigious natural streams which intersect her vast territory over so many thousands of miles literally swarm with steam-boats, but she has, besides, constructed a system of canal navigation which may boldly challenge comparison with anything of the same kind existing in the oldest, wealthiest, and most civilised states of Europe.

It appears from the official statistics that, on the 1st of January, 1843, the extent of canals in actual operation amounted to 4333 miles, and that there were then in progress 2359 miles, a considerable portion of which has since been completed, so that it is probable that the actual extent of artificial water communication now in use in the United States considerably exceeds 5000 miles. The average cost of executing this prodigious system of artificial water communication was at the rate of 6432*l.* per mile, so that 5000 miles would have absorbed a capital of above 32,000,000*l.*

This extent of canal transport, compared with the population, exhibits in a striking point of view the activity and enterprise which characterise the American people. In the United States there is a mile of canal navigation for every 5000 inhabitants, while in England the proportion is a mile to every 9000 inhabitants, and in France a mile to every 13,000. The ratio, therefore, of this instrument of inter-

communication in the United States is greater than in the United Kingdom, in proportion to the population, as 9 to 5, and greater than in France in the ratio of 13 to 5.

The extent to which the American people have fertilised, so to speak, the natural powers of those vast collections of water which surround and intersect their territory is not less remarkable than their enterprise in constructing artificial lines of water communication. Besides the internal communication supplied by the rivers, properly so called, a vast apparatus of liquid transport is derived from the geographical character of their extensive coast, stretching over a space of more than 4000 miles, from the Gulf of St. Lawrence to the delta of the Mississippi, indented and serrated with natural harbours and sheltered bays, fringed with islands forming sounds, throwing out capes and promontories which enclose arms of the sea in which the waters are free from the roll of the ocean, and which, for all the purposes of navigation, have the character of rivers and lakes. The lines of communication formed by the vast and numerous rivers are, moreover, completed in the interior by chains of lakes presenting the most extensive bodies of fresh water in the known world.

Whatever question may be raised on the conflicting claims for the invention of steam navigation, it is an incontestable fact that the first steam-boat practically applied for any useful purpose was placed on the Hudson, to ply between New York and Albany, in 1808; and, from that time to the present, that river has been the theatre of the most remarkable series of experiments of locomotion on water ever recorded in the history of man. The Hudson is navigable by steamers of the largest class as high as Albany, a distance of nearly 150 miles from New York. The steam navigation upon this river is entitled to attention, not only because of

the immense traffic of which it is the vehicle, but because it forms a sort of model for all the rivers of the Atlantic States. Two classes of steamers work upon it — one appropriated to the swift transport of passengers, and the other to the towing of the vast traffic which is maintained between the city of New York and the interior of the state of that name, into the heart of which the Hudson penetrates.

The passenger steamers present a curious contrast to the sea-going steamers with which we are familiar. Not having to encounter the agitated surface of the ocean, they are supplied with neither rigging nor sails, are built exclusively with a view to speed, are slender and weak in their structure, with great length in proportion to their beam, and have but small draught of water. The position and form of the machinery are peculiar. The engines are placed on deck in a comparatively elevated situation. It is but rarely that two engines are used. A single engine placed in the centre of the deck drives a crank constructed on the axle of the enormous paddle-wheels, the magnitude of which, and the velocity imparted to them, enable them to perform the office of fly-wheels. These vessels, which are of great magnitude, are splendidly fitted up for the accommodation of passengers, and have been within the last ten or twelve years undergoing a gradual augmentation of magnitude, to which it would seem to be difficult to set a limit.

It appears from returns obtained by Dr. Lardner from official sources, and published in detail by him in his work on Railway Economy, that the steam-vessels working on the Hudson have for several years back been progressively increased in their magnitude and power, diminished in their draught of water, and increased in the play of the expansive principle. The following were the average dimensions of these vessels in 1838 and 1850: —

	1838.	1850.
	Feet.	Feet.
Length of deck - - - -	200	310
Breadth of beam - - - -	26	35·6
Diameter of wheels - - - -	24·8	35·0

It appears, therefore, that the *average* length of these prodigious floating hotels is above 300 feet! Some of them exceed this length. Thus the "Hendrick Hudson" measures 320, and the "Isaac Newton" 333 feet: the former measuring 35 feet, and the latter 40 feet 4 inches, in the beam. The measured capacity of the "Hendrick Hudson" is 1050 tons, that of the "Isaac Newton" being 1260 tons. In the passenger accommodation afforded by them no water communication in any country of the world can compete. Nothing can exceed the splendour and luxury with which they are fitted up, furnished, and decorated. Silk, velvet, the most costly carpetings and upholstery, vast mirrors, gilding, and carving, are profusely displayed in their decoration. Even the engine-room in some of them is lined with mirrors. In the "Alida," for example, the end of the engine-room is one vast mirror, in which the movements of the brilliant and highly-finished machinery are reflected. All the largest class are capable of running 22 miles an hour, and average nearly 20 miles without difficulty.

It may be observed, in relation to the navigation of those eastern rivers (for we do not here speak of the Mississippi and its tributaries), that the occurrence of explosions is almost unheard of. During the last ten years not a single catastrophe of this kind has been recorded, although cylindrical boilers 10 feet in diameter, composed of plating $\frac{5}{16}$ths of an inch thick, are commonly used, with steam of 50 lb. pressure.

Previously to 1844 the lowest fare from New York to

Albany, a distance of 145 miles, was 4*s*. 4*d*.; at present the fare is 2*s*. 2*d*.; and for an additional sum of the same amount the passenger can command the luxury of a separate cabin. When the splendour and magnitude of the accommodation is considered, the magnificence of the furniture and accessories, and the luxuriousness of the table, it will be admitted that no similar example of cheap locomotion can be found in any part of the globe. Passengers may there be transported in a floating palace, surrounded with all the conveniences and luxuries of the most splendid hotel, at the average rate of 20 miles an hour, for less than *one-sixth of a penny per mile!* It is not an uncommon occurrence during the warm season to meet persons on board these boats who have lodged themselves there permanently, in preference to hotels on the banks of the river. Their daily expenses in the boat are as follows :—

	s.	d.
Fare - - - - - -	2	2
Separate bedroom - - - -	2	2
Breakfast, dinner, and supper - -	6	6
Total daily expense for board, lodging, attendance, and travelling 150 miles at 20 miles an hour - - - - -	10	10

Such accommodation is, on the whole, more economical than an hotel. The bed-room is as luxuriously furnished as the handsomest chamber in an hotel or private house, and is much more spacious than the room similarly designated in the largest packet ships. *

The other class of steamers used for towing the commerce of the river, corresponds to the goods trains on railways. No spectacle can be more remarkable than this class of loco-

* Lardner's Railway Economy, p. 377.

motive machines, dragging their enormous load up the Hudson. They may be seen in the midst of this vast stream, surrounded by a cluster of 20 or 30 loaded craft of various magnitudes. Three or four tiers are lashed to them at each side, and as many more at their bow and at their stern. The steamer is almost lost to the eye in the midst of this crowd of vessels which cling around it, and the moving mass is seen to proceed up the river, no apparent agent of propulsion being visible, for the steamer and its propellers are literally buried in the midst of the cluster which clings to it and floats round and near it.

As this *water goods-train*, for so it may be called, ascends the river, it drops off its load, vessel by vessel, at the towns which it passes. One or two are left at Newburgh, another at Powkeepsie, two or three more at Hudson, one or two at Fishkill, and, in fine, the tug arrives with a residuum of some half-dozen vessels at Albany.

The steam navigation of the Mississippi and the other western rivers is conducted in a manner entirely different from that of the Hudson. Every one must be familiar with the lamentable accidents which happen from time to time, and the loss of life from explosion which continually takes place on those rivers. Such catastrophes, instead of diminishing with the improvement of art, seem rather to have increased. Engineers have done literally nothing to check the evil.

In a Mississippi steam-boat the cabins and saloons are erected on a flooring six or eight feet above the deck, upon which and under them the engines are placed, which are of the coarsest and most inartificial structure. They are invariably worked with high-pressure steam, and, in order to obtain that effect which in the Hudson steamers is due to a vacuum, the steam is worked at an extraordinary pressure. We have

ourselves actually witnessed boilers of this kind, on the western rivers, working under a full pressure of 120 lbs. per square inch above the atmosphere, and we have been assured that this pressure has been recently considerably increased; and it is said that they have sometimes been seen working with a bursting pressure of 200 lbs. per square inch!

The practice of taking a permanent lodging on board a river steamer instead of an hotel is much more frequent on the western rivers, than on the Hudson. This is especially the practice of the gambling fraternity, a race which abounds in these States, and who are ever ready to avail themselves of the opportunity presented by the idleness of a long voyage of ten days and upwards to prey upon the unwary traveller.

A large inland water traffic is carried on between Chicago, Illinois, the southern shores of Lake Michigan, the ports along the shores of Lake Erie, and the river St. Lawrence. Flour is thus sent without transhipment from the prairies of Wisconsin and Illinois to Quebec and New York; and in a few years, when a short canal now in course of construction shall have been finished, there will be one continuous line of water transport connecting the heads of the Mississippi with the embouchures of the Hudson and the St. Lawrence.

The steamers which ply upon the northern lakes are somewhat similar in their construction and accommodation to the steamers of the Hudson, but are stronger built to enable them to withstand the terrific gales to which they are so often exposed.

As might naturally be expected, the chief theatre of railway enterprise in America is the Atlantic States. The Mississippi and its tributaries have served the purposes of commerce and intercommunication to the comparatively thinly scattered population of the Western States so efficiently, that many years will probably elapse, notwithstanding

the extraordinary enterprise of the people, before any considerable extent of railway communication will be established in this part of the States. Nevertheless, the traveller in these distant regions encounters occasionally detached examples of railways even in the valley of the Mississippi. In the State of Mississippi there are five short lines, ten or twelve in Louisiana, and a limited number scattered over Florida, Alabama, Illinois, Michigan, Indiana, and Ohio. These, however, are generally detached and single lines, unconnected with the vast network which we shall presently notice. To the traveller in these wild regions, the aspect of such artificial agents of transport in the midst of a country, a great portion of which is still in the state of native forest, is most remarkable, and strongly characteristic of the irrepressible spirit of enterprise of its people. Travelling in the back woods of Mississippi, through native forests, where till within a few years human foot never trod, through solitudes, the silence of which was never broken, even by the red man, we have been sometimes filled with wonder to find ourselves transported by an engine constructed at Newcastle-on-Tyne, and driven by an artisan from Liverpool, at the rate of 20 miles an hour. It is not easy to describe the impression produced by the juxtaposition of these refinements of art and science with the wildness of the country, where one sees the frightened deer start from its lair at the snorting of the ponderous machine and the appearance of the snake-like train which follows it.

The first American railway was opened for passengers on the last day of 1829. According to the reports collected and given in detail in the work already quoted, it appears that in 1849, after an interval of just 20 years, there were in actual operation 6565 miles of railway in the States. The cost of construction and plant of this system of railways

appears by the same authority to have been 53,386,885*l.*, being at the average rate of 8129*l.* per mile.*

The reports collected in Dr. Lardner's work come up to the middle of 1849. We have, however, before us documents which supply data to a more recent period, and have computed from them the following table, exhibiting the number of miles of railway in actual operation in the United States, the capital expended in their construction and plant, and the length of the lines which are in process of construction, but not yet completed: —

	Railways in Operation.	Cost of Construction and Plant.	Railways projected and in progress.	Cost per Mile.
	Miles.	£	Miles.	£
Eastern States, including Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut - -	2,845	23,100,987	567	8,123
Atlantic States, including New York, the Jerseys, Pennsylvania, Delaware, and Maryland - - - - -	3,503	27,95 2,500	2,020	7,979
Southern States, including Virginia, the Carolinas, Georgia, Florida, and Alabama -	2,106	8,253,130	1,283	3,919
Western States, including Mississippi, Louisiana, Texas, Tennessee, Kentucky, Ohio, Michigan, Indiana, Illinois, Missouri, Iowa, and Wisconsin - - - -	1,835	7,338,290	5,762	3,999
Totals and averages - -	10,289	66,644,907	9,632	6,478

The rate at which this prodigious extent of public works has been executed will appear by the following table, which we take from a report lately published in the *New York Herald*: —

* See Lardner's Railway Economy. chap. xvi.

Year.	Miles in Operation.
1827	3
1830	167
1832	213
1835	787
1840	2,380
1845	3,659
1846	4,144
1847	4,249
1848	5,258
1849	7,000
1850	8,797
1851	10,000

It must be admitted that the results here exhibited present a somewhat astonishing spectacle. It appears from this statement that there are in actual operation in the United States 10,289 miles of railway, and that there are 9632 projected and in process of execution. So that when a few years more shall have rolled away this extraordinary people will actually have 20,000 miles of iron road in operation.

It results from the above, compared with the previous report quoted from Dr. Lardner, that the average cost of construction has been diminished as the operations progressed. According to Dr. Lardner, the average cost of construction of the 6500 miles of railway in operation in 1849 was 8129*l.* per mile, whereas it appears from the preceding table that the actual cost of 10,289 miles now in operation has been at the average rate of 6478*l.* per mile. On examining the analysis of the distribution of these railways among the States, it appears that this discordance of the two statements is apparent rather than real, and proceeds from the fact that the railways opened since Dr. Lardner's report, being chiefly

in the southern and western States, are cheaply constructed lines, in which the landed proprietors have given to a great extent their gratuitous co-operation, and in which the plant and working stock is of very small amount, so that their average cost per mile is a little under 4000*l*., the average cost per mile in the eastern and northern States corresponding almost to a fraction with Dr. Lardner's estimate. It is also worthy of observation that the distribution of this network of railways is extremely unequal, not only in quantity, but in its capability, as indicated by its expense of construction. Thus, in the populous and wealthy States of Massachusetts, New Jersey, and New York, the proportion of railways to surface is considerable, while in the southern and western States it is trifling. In the following table is given the number of miles of surface for each mile of railway in some of the principal States: —

	Square Miles of Surface for each Mile of Railway.
Massachusetts - - - -	7
New Jersey - - - - -	22
New York - - - - -	28
Maryland - - - - -	31
Ohio - - - - -	58
Georgia - - - - -	76

The States of Ohio, Indiana, and Illinois, which form the great highway along which the vast tide of western emigration flows, have, within the last few years, been making extraordinary exertions to complete an extensive system of internal railway communication; and, before ten years shall have elapsed, their extensive territory will be literally overspread with a network of railways and canals.

A glance at any recent map of the internal communications of the United States will fill any reflecting observer with astonishment at the enterprise of this extraordinary people. A line of railway, already 1200 miles in length, and which is incessantly increasing, stretches along the Atlantic coast. There are besides not less than eight great trunk lines extending from the seaboard to the interior: —

	Miles.
1. Portland (Maine) to Montreal, communicating with the St. Lawrence and Ottowa rivers - - -	300
2. Boston to Ogdensburg, where the St. Lawrence issues from Lake Ontario - - - - -	400
3. Boston to Buffalo on Lake Erie - - - -	600
4. New York to Lake Erie - - - -	400
5. Philadelphia to Pittsburgh on the Ohio - - -	400
6. Baltimore to the Ohio - - - - -	350
7. Charleston, South Carolina, to Chatianoogy, in Tennessee	350
8. Savannah, Georgia, to Decatur, Georgia, and Montgomery, on the Alabama - - - -	500

There are also now in progress of construction several detached lines of railway along the southern shores of the great lakes, intended to connect together the numerous cross lines which traverse that country, and so to form an unbroken system of railway communication with the interior. An extensive line commencing at Galena, on the Upper Mississippi, in the heart of the mining region, crosses the state of Illinois, and passing Chicago, skirts the southern shore of Lake Michigan. This line is now complete and under traffic. From Michigan city it crosses the state of that name, arriving at Sandusky, on the southern shore of Lake Erie. The greater part of this section is under traffic, and the remainder in a forward state. From Sandusky this vast artery, following the shore of the lake, arrives at Dunkirk, where it unites

with several great trunk lines, which, traversing the states of New York and Pennsylvania, communicate with the seaboard at Baltimore, Philadelphia, and New York. The extent of this line, running west and east from the Mississippi to the Atlantic, is not less than 1800 miles.

When it is considered that the railways in this country have cost upon an average about 40,000*l*. per mile, the comparatively low cost of the American railways will doubtless appear extraordinary.

This circumstance, however, is explained partly by the general character of the country, partly by the mode of constructing the railways, and partly by the manner of working them. With certain exceptions, few in number, the tract of country over which these lines are carried is nearly a dead level. Of earthwork there is but little; of works of art, such as viaducts and tunnels, commonly none. Where the railways are carried over streams or rivers, bridges are constructed in a rude but substantial manner of timber supplied from the roadside forest, at no greater cost than that of hewing it. The station houses, booking offices, and other buildings, are likewise slight and cheaply constructed of timber. On some of the best lines in the more populous states the timber bridges are constructed with stone pillars and abutments, supporting arches of trusswork, the cost of such bridges varying from 46*s*. per foot, for 60 feet span, to 6*l*. 10*s*. per foot for 200 feet span, for a single line, the cost on a double line being 50 per cent. more.

When the railways strike the course of rivers such as the Hudson, Delaware, or Susquehanna — too wide to be crossed by bridges — the traffic is carried by steam ferries. The management of these ferries is deserving of notice. It is generally so arranged that the time of crossing them corresponds with a meal of the passengers. A platform is con-

structed level with the line of railway and carried to the water's edge. Upon this platform rails are laid by which the waggons which bear the passengers' luggage and other matters of light and rapid transport are rolled directly upon the upper deck of the ferry boat, the passengers meanwhile going under a covered way to the lower deck. The whole operation is accomplished in five minutes. While the boat is crossing the spacious river the passengers are supplied with their breakfast, dinner, or supper, as the case may be. On arriving at the opposite bank the upper deck comes in contact with a like platform, bearing a railway upon which the luggage waggons are rolled; the passengers ascend, as they descended, under a covered way, and, resuming their places in the railway carriages, the train proceeds.

But the prudent Americans have availed themselves of other sources of economy by adopting a mode of construction adapted to the expected traffic. Formed to carry a limited commerce, the railways are frequently single lines, sidings being provided at convenient situations. Collision is impossible, for the first train which arrives at a siding must enter it, and remain there until the following train arrives. This arrangement would be attended with inconvenience with a crowded traffic like that of many lines on the English railways, but even on the principal American lines the trains seldom pass in each direction more than twice a day, and their time and place of meeting is perfectly regulated. In the structure of the roads, also, principles have been adopted which have been attended with great economy compared with the English lines. The engineers, for example, do not impose on themselves the difficult and expensive condition of excluding all curves but those of large radius, and all gradients exceeding a certain small limit of steepness. Curves of 500 feet radius, and

even less, are frequent, and acclivities rising at the rate of 1 foot in 100 are considered a moderate ascent, while there are not less than 50 lines laid down with gradients varying from 1 in 100 to 1 in 75; nevertheless, these lines are worked with facility by locomotives, without the expedient even of assistant or stationary engines. The consequences of this have been to reduce in an immense proportion the cost of earthwork, bridges, and viaducts, even in parts of the country where the character of the surface is least favourable. But the chief source of economy has arisen from the structure of the line itself. In many cases where the traffic is lightest the rails consist of flat bars of iron, 2½ inches broad and 6-10ths of an inch thick, nailed and spiked to planks of timber laid longitudinally on the road in parallel lines, so as to form what are called continuous bearings. Some of the most profitable American railways, and those of which the maintenance has proved least expensive, have been constructed in this manner. The road structure, however, varies according to the traffic. Rails are sometimes laid weighing only from 25 lbs. to 30 lbs. per yard. In some cases of great traffic they are supported on transverse sleepers of wood like the European railways; but in consequence of the comparative cheapness of wood and the high price of iron, the strength necessary for the road is mostly obtained by reducing the distance between the sleepers so as to supersede the necessity of giving greater weight to the rails.

The same observance of the principles of economy is maintained with regard to their locomotive stock. The engines are strongly built, safe, and powerful, but are destitute of much of that elegance of exterior and beauty of workmanship which have excited so much admiration in the machines exhibited in the Crystal Palace. The fuel is generally wood, but on certain lines near the coal districts coal is used. The

use of coke is nowhere resorted to. Its expense would make it inadmissible, and in a country so thinly inhabited, the smoke proceeding from coal is not objected to. The ordinary speed, stoppages included, is from 14 to 16 miles an hour. Independently of other considerations, the light structure of many of the roads would not allow a greater velocity without danger; nevertheless, we have frequently travelled on some of the better constructed lines at the ordinary speed of the English railways, say 30 miles an hour and upwards.

Of late years, however, many exceptions to this system of economical construction are presented. The competition for goods traffic which has been recently produced by the great and rapid extension of railway communication, has induced the companies to impose a more strict limit on the gradients and curves, and the engineer is often restricted in laying out the line to gradients not exceeding 40 feet per mile, and curves of not less than 2000 feet radius.

The lines are also more generally now built with greater solidity. The flat bar rail is fast giving way to rails of the more durable form, weighing from 40 to 60 lbs. per yard. On the Camden and Amboy road, rails have lately been laid down, having a depth of not less than 7 inches, and weighing 90 lbs. per yard.

Within the last few years, also, more attention has been given to the style of the engines. They still continue generally light compared with the English locomotives, but the working machinery vies with that of the river boats in beauty of workmanship, and the engine is often even covered with a profusion of superfluous ornament.

On the railways of the Northern and Eastern States, the platform on which the engine driver stands is now invariably surrounded and covered so as to shelter the engine driver from the inclemency of the weather, from the cold, wind, and

snow in winter, and the scorching rays of the sun in summer. This covering is glazed at the front and the sides, so as to enable the driver to see the line before him, and at either side, and to prevent, at the same time, the blinding effect of rain, snow, or sleet. He is thus always enabled to act with promptitude and energy in case of any accident or emergency.

All passenger carriages on these lines, which make long trips of above twelve hours, are furnished at one extremity with a saloon for ladies only, supplied with sofas, chairs, and all the necessary comforts and conveniences.

Notwithstanding the apparently feeble and unsubstantial structure of many of the lines, accidents to passenger trains are scarcely ever heard of. It appears by returns now before us that of 9,355,474 passengers booked in 1850 on the crowded railways of Massachusetts, each passenger making an average trip of 18 miles, there were only 15 who sustained accidents fatal to life or limb. It follows from this, by the common principles explained by us in a former article, that when a passenger travels one mile on these railways, the chances against an accident producing personal injury, even of the slightest kind, are 11,226,568 to 1, and, of course, in a journey of 100 miles, the chances against such accident are 112,266 to 1. We have shown, in a former article, that the chances against accident on an English railway, under like circumstances, are 85,125 to 1. The American railways are, therefore, safer than the English in the ratio of 112 to 85.

A great line of communication was established, 400 miles in length, between Philadelphia and Pittsburg, on the left bank of the Ohio, composed partly of railway and partly of canal. The section from Philadelphia to Colombia (82 miles) is railway; the line is then continued by canal for

172 miles to Holidaysburg; it is then carried by railway 37 miles to Johnstown, whence it is continued 104 miles further to Pittsburg by canal. The traffic on this mixed line of transport is conducted so as to avoid the expense and inconvenience of transhipment of goods and passengers at the successive points where the railway and canals unite. The merchandize is loaded and the passengers accommodated in the boats adapted to the canals at the depôt in Market Street, Philadelphia. These boats, which are of considerable magnitude and length, are divided into segments by partitions made transversely, and at right angles to their length, so that such boat can be, as it were, broken into three or more pieces. These several pieces are placed each on two railway trucks, which support it at its ends, a proper body being provided for the trucks, adapted to the form of the bottom and keel of the boat. In this manner the boat is carried in pieces, with its load, along the railway. On arriving at the canal, the pieces are united so as to form a continuous boat, which being launched, the transport is continued on the water. On arriving again at the railway, the boat is once more resolved into its segments, which, as before, are transferred to the railway trucks and transported to the next canal station by locomotive engines. Between the depôt in Market Street and the locomotive station, which is situated in the suburbs of Philadelphia, the segments of the boat are drawn by horses on railways conducted through the streets. At the locomotive station the trucks are formed into a continuous train and delivered over to the locomotive engine. As the body of the truck rests upon a pivot, under which it is supported by wheels, it is capable of revolving, and no difficulty is found in turning the shortest curves; and these enormous vehicles, with their contents of merchandize and passengers, are seen daily issuing from the gates of the

depôt in Market Street, and turning with facility the corners at the entrance of each successive street.

More recently, a continuous line of railway has been completed, and is now in operation between Philadelphia and Pittsburg. Indeed, so rapid is the progress of improvement in the United States, that a report of the state of inland communication as it existed a year or two ago, will be found to be full of inaccuracies as applied to the present moment.

By a comparison of the returns published by Dr. Lardner in his work already quoted, with the more recent results which we have already given, it will appear that within the last two years not less than 3700 miles of railway have been opened for traffic in the United States. Among these are included several of the most important lines, of which the most especially to be noticed is the great artery of railway communication extending across the State of New York to the shores of Lake Erie, the longest line which any single company has yet constructed in the United States, its length being 467 miles. The total cost of this line, including the working stock, has been 4,500,000*l.* sterling, being at the average rate of 9642*l.* per mile—a rate of expense about 50 per cent above the average cost of the American railways taken collectively. This is explained by the fact that the line itself is one constructed for a large traffic between New York and the Interior, and therefore built to meet a heavy traffic. Although it is but just opened, its average receipts have amounted to 11,000*l.* per week, which have given a net profit of 6½ per cent on the capital, the working expenses being taken at 50 per cent of the gross receipts. One of the great lines in a forward state, and likely to be soon opened, connects New York with Albany, following the valley of the Hudson. It will

no doubt create surprise, considering the immense facility of water transport afforded by this river, that a railway should be constructed on its bank, but it must be remembered that for a considerable interval during the winter the navigation of the Hudson is suspended from the frost.

A great line of railway, which will intersect the States from south to north, connecting the port of Mobile on the Gulf of Mexico with Lake Michigan and the lead mines of Galena on the Upper Mississippi, is also in progress of construction, large grants of land being conceded to the company by the Federal Government. This line will probably be opened in 1854.

It is difficult to obtain authentic reports from which the movement of the traffic on the American railways can be ascertained with precision. Dr. Lardner, however, obtained the necessary statistical data relating to nearly 1200 miles of railway in the states of New England and New York, from which he was enabled to collect all the circumstances attending the working of these lines.

It appears from his calculations, the details of which will be found in his work, that upon those railways the total average receipts per mile per annum was 4694*l.*, and that the profit per cent of capital amounted to 8·6 per cent.

These lines, however, are the most active and profitable in the United States. It would, therefore, be a great error to infer, from the results here exhibited, general conclusions as to the financial condition of the American railways. It appears, on the other hand, from a more complete analysis, that the dividends on the American lines, exclusive of those contained in the preceding analysis, are in general small, and in many instances nothing. It is therefore probable, that in the aggregate the average profits on the total amount of

capital invested in the American railways, does not much exceed those realised by the railways of the United Kingdom.

The extraordinary extent of railway constructed at so early a period in the United States has been by some ascribed to the absence of a sufficient extent of communication by common roads. Although this cause has operated to some extent in certain districts, it is by no means so general as has been supposed. In the year 1838 the United States mails circulated over a length of way amounting on the whole to 136,218 miles, of which two-thirds were land transport, including railways as well as common roads. Of the latter there must have been about 80,000 miles in operation, of which, however, a considerable portion was bridle-roads. The price of transport in the stage coaches was, upon an average, 3·25*d.* per passenger per mile, the average price by railway being about 1·47*d.* per mile.*

Of the entire extent of railway constructed in the United States, by far the greater portion, as has been already explained, consists of single lines, constructed in a light and cheap manner, which in England would be regarded as merely serving temporary purposes; while, on the contrary, the entire extent of the English system consists, not only of double lines, but of railways constructed in the most solid, permanent, and expensive manner, adapted to the purposes of an immense traffic. If a comparison were to be instituted at all between the two systems, its basis ought to be the capital expended, and the traffic served by them, in which case the result would be somewhat different from that obtained by the mere consideration of the length of the lines. It is not, however, the same in reference to the canals, in which it

* Lardner's Railway Economy, p. 408.

must be admitted America far exceeds all other countries in proportion to her population.

The American railways have been generally constructed by joint stock companies, which, however, the State controls much more stringently than in England. In some cases a major limit to the dividends is imposed by the statute of incorporation, in some the dividends are allowed to augment, but when they exceed a certain limit the surplus is divided with the State; in some the privilege granted to the companies is only for a limited period, in some a sort of periodical revision and restriction of the tariff is reserved to the State. Nothing can be more simple, expeditious, and cheap than the means of obtaining an act for the establishment of a railway company in America. A public meeting is held at which the project is discussed and adopted, a deputation is appointed to apply to the Legislature, which grants the act without expense, delay, or official difficulty. The principle of competition is not brought into play as in France, nor is there any investigation as to the expediency of the project with reference to future profit or loss as in England. No other guarantee or security is required from the company than the payment by the shareholders of a certain amount, constituting the first call. In some States the non-payment of a call is followed by the confiscation of the previous payments, in others a fine is imposed on the shareholders, in others the share is sold, and if the produce be less than the price at which it was delivered, the surplus can be recovered from the shareholder by process of law. In all cases the acts creating the companies fix a time within which the works must be completed, under pain of forfeiture. The traffic in shares before the definite constitution of the company is prohibited.

Although the State itself has rarely undertaken the exe-

cution of railways, it holds out, in most cases, inducements in different forms to the enterprise of companies. In some cases the State takes a great number of shares, which is generally accompanied by a loan made to the company, consisting in State stock delivered at par, which the company negotiate at its own risk. This loan is often converted into a subvention.

The great extent of railway communication in America in proportion to its population must necessarily excite much admiration. If we take the present population of the United States at 24,000,000, and the railways in operation at 10,000 miles, it will follow that in round numbers there is one mile of railway for every 2400 inhabitants. Now, in the United Kingdom there are at present in operation 6500 miles of railway, and if we take the population at 28,000,000, it will appear that there is a mile of railway for every 4300 inhabitants. It appears, therefore, that in proportion to the population, the length of railways in the United States is greater than in the United Kingdom in the ratio of 43 to 24.

On the American railways passengers are not differently classed or received at different rates of fare as on those of Europe. There is but one class and one fare. The only distinction observable arises from colour. The coloured population, whether emancipated or not, are generally excluded from the vehicles provided for the whites. Such travellers are but few, and are usually accommodated either in the luggage van or in the carriage with the guard or conductor. But little merchandize is transported, the cost of transport being greater than goods in general are capable of paying; nevertheless, a tariff regulated by weight alone, without distinction of classes, is fixed for merchandize.

Although Cuba is not yet *annexed* to the United States, its local proximity here suggests some notice of a line of

railway which traverses that island, forming a communication between the city of Havannah and the centre of the island. This is an excellently constructed road, and capitally worked by British engines, British engineers, and British coals. The impressions produced in passing along this line of railway, though different from those already noticed in the forests of the far west, is not less remarkable. We are here transported at thirty miles an hour by an engine from Newcastle, driven by an engineer from Manchester, and propelled by fuel from Liverpool, through fields yellow with pine-apples, through groves of plantain and cocoa-nut, and along roads inclosed by hedge-rows of ripe oranges.

To what extent this extraordinary rapidity of advancement made by the United States in its inland communications is observable in other departments will be seen by the following table, exhibiting a comparative statement of those *data*, derived from official sources, which indicate the social and commercial condition of a people through a period which forms but a small stage in the life of a nation: —

	1793.	1851.
Population - - - -	3,939,325	24,267,488
Imports - - - -	£6,739,130	£38,723,545
Exports - - - -	£5,675,869	£32,367,000
Tonnage - - - -	520,704	3,535,451
Lighthouses, beacons, and lightships	7	373
Cost of their maintenance - -	£2,600	£115,000
Revenue - - - -	£1,230,000	£9,516,000
National expenditure - -	£1,637,000	£8,555,000
Post-offices - - -	209	21,551
Post roads (miles) - - -	5,642	178,670
Revenue of Post-office - -	£22,800	£1,207,000
Expenses of Post-office - -	£15,650	£1,130,000
Mileage of mails - - -	—	46,541,423
Canals (miles) - - -	—	5,000
Railways (miles) - - -	—	10,287
Electric telegraph (miles) - -	—	15,000
Public libraries (volumes) - -	75,000	2,201,623
School libraries (volumes) - -	—	2,000,000

If they were not founded on the most incontestable statistical data, the results assigned to the above table would appear to belong to fable rather than history. In an interval of little more than half a century it appears that this extraordinary people have increased above 500 per cent in numbers; their national revenue has augmented nearly 700 per cent, while their public expenditure has increased little more than 400 per cent. The prodigious extension of their commerce is indicated by an increase of nearly 500 per cent in their imports and exports, and 600 per cent in their shipping. The increased activity of their internal communications is expounded by the number of their post-offices, which has been increased more than a hundred fold, the extent of their post roads, which has been increased thirty-six fold, and the cost of their post-office, which has been augmented in a seventy-two fold ratio. The augmentation of their machinery of public instruction is indicated by the extent of their public libraries, which have increased in a thirty-two fold ratio, and by the creation of school libraries, amounting to 2,000,000 volumes. They have completed a system of canal navigation, which, placed in a continuous line, would extend from London to Calcutta, and a system of railways which, continuously extended, would stretch from London to Van Diemen's Land, and have provided locomotive machinery by which that distance would be travelled over in three weeks, at the cost of $1\frac{1}{2}d.$ per mile. They have created a system of inland navigation, the aggregate tonnage of which is probably not inferior in amount to the collective inland tonnage of all the other countries in the world, and they possess many hundreds of river steamers, which impart to the roads of water the marvellous celerity of roads of iron. They have, in fine, constructed lines of electric telegraph which, laid continuously, would extend over a space longer

by 3000 miles than the distance from the north to the south pole, and have provided apparatus of transmission by which a message of 300 words despatched under such circumstances from the north pole might be delivered *in writing* at the south pole in one minute, and by which, consequently, an answer of equal length might be sent back to the north pole in an equal interval.

These are social and commercial phenomena for which it would be vain to seek a parallel in the past history of the human race.

VII.

SYNOPSIS OF RAILWAY TRANSPORT AT HOME AND ABROAD.

Our review of the railway machinery of the Great Exhibition having led incidentally to a brief sketch of the vast system of railways which overspread these islands, to the facilities of locomotion presented by which the Great Exhibition itself mainly owes its practicability, it appears in some degree necessary, as a supplement to our report, to notice what has been accomplished in this new art of locomotion in other countries, and to compare the result of these great enterprises with each other and with those which we have ourselves attained.

Having, therefore, noticed in some detail what our descendants have accomplished at the other side of the Atlantic, we propose at present to call attention to the railway system of the Continent.

Belgian Railways.

The first state of Europe which followed in the wake of England as respects railways was Belgium. Its independence

had scarcely been acknowledged by the great powers of Europe, when the statesmen to whom its government was confided after the revolution of 1830, seeing the isolation in which it stood, resolved to confer upon it, by an effort of enterprise and art, that influence in Europe which was denied to it by its insignificant territory, its small population, and limited commerce. It was therefore resolved to overspread it with a network of railways, which should render it the great highway for a large share of the commerce and intercourse of Europe.

The port of Ostend was selected as the chief terminus for passenger traffic, and that of Antwerp for merchandize. Two great trunk lines—one connecting Ostend with the Prussian frontier, near Aix-la-Chapelle, and the other connecting Antwerp with the French frontier, near Valenciennes, passing through Brussels, and intersecting the former at Malines,—were accordingly laid out and constructed. Subservient to these were several cross-lines and secondary branches.

By means of this system of railways the small state of Belgium has, as its government intended should happen, become the great highway for the commerce and personal intercourse between Central Europe and the German Ocean. A large traffic is also maintained with France.

The total length of the Belgian railways is 532 miles, of which 353 have been constructed and worked by the State, the remainder being distributed between different private companies.

The stimulus which this vast improvement in inland transport imparted to the commerce of Belgium may be inferred from the following facts, stated with others in detail in the work on *Railway Economy*, from which we have already so largely quoted.

In the year 1836, when the construction of this system of railways had only just commenced, the imports of Belgium amounted to 8,356,000*l.*, and the exports to 6,620,000*l.* In ten years later, even before the projected system of railways had been quite completed, the imports had augmented 50 per cent, and the exports 100 per cent, the former amounting to 12,640,000*l.*, and the latter to 12,480,000*l.*

In 1839, the value of the imports and exports at the port of Antwerp was 5,600,000*l.*; in 1843, they exceeded 9,000,000*l.*

The production of coal in Belgium was doubled in the ten years ending in 1845, and the production of iron in the same interval was augmented in a sevenfold proportion. In the same interval the importation of raw cotton was nearly doubled, and that of wool augmented nearly 40 per cent.

The general character of the country was favourable to the construction of railways, but much more stress has been laid on this circumstance by those who desire to explain the rapid advance made in this improvement in Belgium than is due to it. It is true that the districts between Brussels and the ocean are in general level, and that but little earthwork and works of art were required, but the country is intersected by numerous rivers and canals, requiring bridges and aqueducts. Between Brussels and the Prussian frontier, however, obstacles were presented requiring works of art of the most expensive and difficult character. Thus, near Louvain, a tunnel is constructed measuring 1000 yards, besides numerous aqueducts, bridges, and viaducts; near Liege, the country falls to the valley of the Meuse with a steep declivity, which necessitated the construction of two inclined planes, worked by stationary engines upon a gradient of 1 in 33.

The extraordinary expedition with which the Belgian railways was completed, was mainly caused by the circumstance

of their being executed by the State under a committee invested with adequate powers.

The system was completed and in full operation at the end of 1847, when it was found that the total cost of the railways executed by the State was 6,359,611*l.*, being at the rate of 18,000*l.* per mile.

Assuming, as we may here do, that the remaining lines were constructed at the same average expense, it will follow that the total expense of the Belgian railways, consisting of 532 miles, has been 9,576,000*l.*, the chief part of which sum was expended in the twelve years ending 31st December, 1847.

The ample commercial details published in the annual reports issued by the Minister of Public Works in Belgium, have supplied the necessary *data* for calculating all the circumstances attending the movement of the traffic and its financial results on the Belgian railways. The receipts, expenses, and profits have been nearly stationary for the last four years. In 1847 and 1851, they were as follows: —

	1847.	1851.
	£	£
Receipts - - - - -	593,444	593,900
Expenses - - - - -	372,756	367,812
Profits - - - - -	220,688	226,088

The expenses are, therefore, 63 per cent of the receipts, and the profits $3\frac{1}{2}$ per cent on the capital.

These results are applicable only to the State lines. The traffic on the lines worked by companies is not, however, materially different.

The traffic here, as elsewhere, is unequally distributed over the system of railways, prevailing in much greater

quantity over certain parts of the system than over others. To estimate the general traffic, it is therefore necessary to show what would be its amount per mile if uniformly distributed. To determine this, it is only necessary to divide the entire receipts by the entire length of the lines, from which it will appear that the average daily receipts of each mile of railway open are 4·6*l*.

By the returns of the performance of the locomotive power, it appears that the total distance run daily by the engines is 6500 miles, from which it follows that every mile of these lines is traversed daily by 18 engines.

Each passenger engine draws 80 passengers, with baggage, parcels, mails, &c., the receipts amounting to 5*s*. per mile per train, the train consisting of from eight to ten vehicles. Each first class passenger travels on an average 37 miles, each second class passenger 26 miles, and each third class passenger 18 miles.

Each goods engine draws on an average 20 goods waggons, carrying a load of 34 tons, and each ton of goods is transported 44 miles. The receipts on each mile run by the goods engine being *5s. 2d.*

The average speed of the passenger trains on the Belgian railways, stoppage included, is 18 miles an hour, and the actual average speed in motion, 25 miles an hour.*

French Railways.

The first passenger railways constructed in France, were those connecting Paris with Versailles and St. Germain, which were opened in 1837.

* For further details of the Belgian Railways, see "Railway Economy," chap. xvii.

In 1838 a grant was made to a company to construct a line of railway between Paris and Orleans; to another for the railway since constructed between Paris and Rouen.

In June, 1842, the law was passed under which the extensive system of railways was defined which has since been partially carried into execution. The system contemplated by this law was to consist of seven principal arteries — the first, directed from Paris upon the Belgian frontier, the second upon one or more ports of the Channel, the third upon the ocean by one or more of the western ports, the fourth upon the Spanish frontier by Bayonne, the fifth upon the Spanish frontier, by Perpignan, proceeding through the centre of France, the sixth upon the Mediterranean by Marseilles, and the seventh upon the Rhine, by Nancy and Strasburg.

Although the general features of this system have been in the main adhered to, the Government has been forced to lay aside most of the conditions of the law of 1842, and to make the best terms it could with the companies who presented themselves, to induce them to undertake and work the railways, and in some cases it has even been found impossible to accomplish this through the medium of private companies, and the Government has been obliged to construct the lines previously, trusting to the probability of finding companies willing to work them when completed.

The first great artery of the system is that now known as the North of France Railway, which, issuing from the suburbs of Paris, goes directly to Amiens, following the valleys of the rivers, such as the Oise, the Brêche, the Aré, and the Somme, which run north and south. From Amiens the line is carried to Douay, where it forks, one branch being directed by Valenciennes upon the Belgian frontier, and the other by Lille upon Calais and Dunkirk. Connected with

this main line are two great branches, from Amiens to Boulogne, and from Oreil to St. Quentin.

The western line is completed, and in operation only as far as Chartres.

The line to be directed from the capital to the Pyrenees at Bayonne, passing by Bordeaux, is completed and in operation as far as Poictiers. The section between that place and Bordeaux is, however, in a forward state, and will probably be open for traffic before the close of 1852, unless interrupted by political convulsions. This great artery of communication throws off an important branch westward from Tours to Nantes, which is also completed and under traffic.

The artery intended to proceed south to the Pyrenees at Perpignan is open as far as Chateauroux, branching from the last-mentioned line at Orleans.

The Great Southern Railway, intended to connect Paris with Marseilles, is open as far as Chalons, the last section between Marseilles and Avignon being also completed and under traffic.

The Eastern line, proceeding from Paris to the Rhine, at Strasburg, is open as far as Bar-le-Duc, and also between Strasburg and Nancy.

In fine, of the entire systems of railways projected, the following was the condition on the 31st of December, 1850: —

	Miles.
Under traffic - - - - -	1,818
In progress - - . - -	1,178
Total length open and in progress - -	2,996
Projected, but not commenced - - -	577
Total - - - -	3,573

Besides which there are about 150 miles of railway for the conveyance of coals and minerals, and many cases of single lines of comparatively small importance.

Owing to the manner in which the French railways have been constructed, it is difficult to ascertain with precision their cost of construction and plant. In some cases the companies have reimbursed, or are under obligations to reimburse, the State for the entire construction of the line; in other cases these expenses remain to the charge of the State, and the companies only provide the remainder of the capital. In the work before us, however, *data* have been obtained by which it appears that the following estimate of the total cost of the passenger lines has been obtained with sufficient precision for all practical purposes: —

1,818 miles open - - - -	£48,780,576
1,178 miles in progress - - -	31,608,096
Open and in progress - -	80,388,672
577 projected but not commenced - -	15,482,064
3,573 miles open, in progress, and projected -	£95,870,736

It appears, therefore, that the cost of construction and plant of the lines in actual operation has been at the rate of 26,832*l.* per mile, the cost of construction of those in progress and projected being here estimated at the same rate.

The French railways in operation and in progress, therefore, have absorbed or will absorb a capital of above 80,000,000*l.*, while those projected, but not yet commenced, will require nearly 15,500,000*l.**

The French railway companies stand in the relation of tenants or lessees towards the State. In many cases the

* Railway Economy, p. 449.

Government proceeded with the construction of the lines long before a grant had been made, or even before the lines were submitted to competition. The surveys were all made, the earthwork and works of art in many cases constructed, and even the road structure itself, and the buildings of the stations, in some cases, erected by the Government. In a word, several of the great lines were already in a forward state at the epochs at which they were submitted to competition, with a view to leasing them to the companies on the best terms for the Government which could be obtained. These terms are fixed by contracts made upon sealed offers similar to those which the British Government enter into for the supplies of the public establishments.

The effect of this system of competition, combined with the railway mania which prevailed at the epoch at which the principal concessions were made, had the effect of greatly abridging the period for which the leases of some of the principal lines have been granted. Instead of 99 years conceded to the earlier companies, the more recent lines have been limited to periods varying from 30 to 40 years.

From an elaborate comparison of the traffic reports published by the French companies, it appears that the average daily receipts for each mile of railway under traffic were 5·3*l.* in 1848; and, by the returns of 1850, they appear to have undergone, since that date, no considerable augmentation.

By a comparison of the movement of the locomotive power with the length of railway under traffic, it appears that every mile of French railway is traversed daily by thirteen engines.

An analysis of the revenue shows that 63 per cent of the gross receipts arose from passenger traffic, and 37 per cent from merchandize, and that the average net profit on the capital invested, taken collectively, does not exceed 27·10 per cent.

From the returns of the movement of the traffic, it results that the average speed upon these railways, stoppages included, is 21·2 miles per hour, and that the speed in motion is 27 miles an hour.

From these averages, however, there are extreme departures; as, for example, in the mail trains between Paris and Calais, which run at a very high speed.*

German Railways.

The continental railways are very unequally distributed, according to the varying prevalence of population, commerce, and industry. A tract east of the frontier of the Netherlands, measuring about 400 miles east and west, and 200 miles north and south, is covered with a dense network of railways, most of which are completed and in operation, and the remainder in very active progress.

This includes the Prussian territory, Hanover, Saxony, and their dependencies, and Brunswick, and the other northern duchies, forming an extensive basin of population, commerce, and industry, subservient and tributary to which all the other systems of railways in the Germanic States may be considered.

These Germanic railways may be considered to consist of four distinct trunk lines running north and south in directions nearly parallel. The first follows the course of the Rhine from Cologne to Basle, having short branches here and there, such as those upon Baden, Manheim, and Spiers. The second runs also north and south through the kingdom of Wurtemberg, having Stuttgard for its point of departure,

* Railway Economy, p. 459.

and abutting upon the shores of Lake Constance. It is proposed to continue this line from the southern shore of the lake across the Alps by the Splugen, descending along the shores of the Lago Maggiore into the plain of Piedmont, and terminating on the field of Marengo under the walls of Alexandria. This line would thus join the Piedmontese network, and communicate with Turin by Genoa. The completion of this artery would form a continuous railway connecting Genoa with the ports of the Baltic, the Sound, the German Ocean, and the Channel.

The third great parallel artery traverses the kingdom of Bavaria, having Munich for its point of departure, being connected with the Saxon system by Augsburgh and Nuremberg, and resting at the south on the shores of the Lake Constance.

This Bavarian trunk line, which terminates for the present at Munich, is to be carried southward and eastward, traversing the Tyrol through Innsbruck and Bautzen, following the pass of the Alps to Trent, and finally uniting at Verona with the Venice and Milan railway, and thus connecting itself with the whole of the network projected to cover Piedmont and the Milanese. Whenever this project shall have been realized, a continuous line of railway communication will connect the Adriatic with the ports of the Baltic, the Sound, the German Ocean, and the Channel.

The fourth great parallel artery, running north and south, traverses Austria, having Vienna for its point of departure, and throwing off numerous and important branches. At the south it will terminate at Trieste, being already open and in operation to a point not very distant from that port. The section of this trunk between Laybach and Trieste crosses the Julian Alps, and will be attended with some engineering operations of a difficult and expensive kind, which, however,

are in rapid progress, so that we may soon expect to see an unbroken line of railway communication extending from Trieste through the Austrian, Saxon, and Prussian States to the shores of the Baltic and the northern seas.

The branch line from the Austrian northern trunk, extending across the entire territory of Bohemia, is complete and in full operation, with the exception of a short section near Dresden.

Prussian Railways.

Berlin is the common centre and point of departure of the extensive system of northern railways. From this capital seven trunk lines will ultimately diverge, of which six are very nearly completed and in operation.

The first connects Berlin with Hamburgh; the second, with Hanover and Dusseldorf; the third, with Halle and Cassel, with a link to Leipsic; the fourth is directed upon Upper Silesia, with a branch to Cracow; the fifth proceeds northwards to Stettin; and the two remaining lines will proceed, one to Strelitz, and the other to Bromberg, in the duchy of Posen.

The total length of railways which were open and in actual operation in the Prussian territory alone on the 31st of December, 1850, amounted to 1812 miles.

In the following table is exhibited the progressive construction and the actual state of the railways of the Germanic States for the four years ending the 31st of December, 1850. We have taken the returns for the three years ending the 31st of December, 1849, from the work already quoted *, and have added the returns of 1850 from recent documents: —

* Railway Economy, p. 467.

Railways.	1845.	1847.	1849.	1850.
	Miles.	Miles.	Miles.	Miles.
Completed, and in operation - -	1,588	2,828	4,542	5,342
In process of construction - -	2,917	2,138	800	700
Total completed, and in process of construction - - -	4,505	4,966	5,342	6,042
Decided to be constructed, and sanctioned by the State - - -	—	1,299		
Total constructed, in progress, and decided on - - -	—	6,265	3,114	2,414
Projected or contemplated, but not finally decided on, or sanctioned by the State - - - -	—	1,921		
Total constructed, in progress, sanctioned, and contemplated	—	8,186	8,456	8,456

It appears, therefore, that at the close of the last year, of 8500 miles of railway projected in the Germanic States, above 5300 miles were in actual operation, and 700 more in rapid progress of construction.

It is necessary to state that in the preceding calculations are included, besides the railways in the states strictly denominated Germanic, those of the Dutch Netherlands, Denmark and the duchies, and the provinces of Austria which are not included in the Confederation.

In the Germanic States, properly so called, the actual extent of railway under traffic at the close of 1850 was 4571 miles, of which four-tenths were constructed and worked by the State, and the remainder, under various conditions and restrictions, by private companies.

The Germanic railways have been constructed in some cases by the State, in some by companies. Those of Baden, Wurtemberg, Bavaria, Hanover, Austria, Brunswick, and the small principalities, have been, with a few exceptions, constructed and worked by the State. Even in a few cases, where the construction of particular lines was confided to

companies, the Governments have for the most part removed them, and taken the management into their own hands.

In Prussia, however, the State has abstained from any direct interference with the construction or working of the railways, but has extended encouragement to the private companies, by which the extensive system of lines that cover its territory has been executed. In cases where the traffic did not offer sufficient encouragement to stimulate private enterprise, the Government has extended its aid, either in the shape of subvention, or by taking shares in the line, or in guaranteeing a *minimum* rate of interest on capital. The Government, however, reserves a power of redemption at the end of thirty years, on the condition of paying to the railway proprietors a capital equal to twenty-five times the average amount of the dividends enjoyed by the shareholders for the preceding five years. The State would in that case assume the responsibilities and debts of the company, but it would at the same time take possession of their entire assets, as well as the reserve fund. The State engages meanwhile not to permit parallel and competing lines to be constructed. The Government also retains a power of controlling the tariff.*

Constructed with a view to a traffic comparatively limited, and resembling closely in their commercial conditions the roads of the United States, the German railways have been constructed in general on principles analogous to those which have been found to answer so well in America.

The vast expenditure for earthwork and costly works of art, such as viaducts, bridges, and tunnels, by which valleys are bestridden and mountains pierced, to gain a straight and level line, on the English system, has not been incurred, and

* Railway Economy, p. 470, *et seq.*

the railways have been carried more nearly along the natural level of the country, the cost of earthwork having been generally limited to that of short cuttings and low embankments. Curves of comparatively short radius have also been admitted, so that the railways might wind along those levels which would offer the most economical conditions of construction.

In some cases, as in the line between Brunswick and Hamburgh, the prevailing gradient is 1 in 166, and between Hamburgh and Weinenburgh the gradients vary from 1 in 50 to 1 in 100,—a steepness which, according to the common principles of English lines, would require either a stationary engine and rope or assistant-engine; nevertheless, no difficulty is encountered in the regular working of this line by locomotives without assistant-engines. We indicated another example of this character of railway, but of much greater length, in the United States, between Boston and Albany. Trains of an average gross weight of 70 tons are drawn commonly between Hamburgh and Weinenburgh by engines whose weight does not exceed 18 tons, having six coupled wheels of 4 feet 9 inches diameter.

The economy of the German railways is further promoted by the conditions observed in their construction. Although sufficient land has been always purchased, and earthwork and works of art in most cases constructed of sufficient width for a double line, one line only has been laid down, except in the neighbourhood of great centres of population and industry, where a traffic sufficient to require a double line might be counted on.

The form and weight of the rails vary according to the traffic. Rails consisting of simple iron bars spiked down on longitudinal planks of wood, like those already described for the American railways, have been used in some cases; as,

for example, in a section of the line between Vienna and Glognitz, and some mineral lines in Austria.

The cost of construction of the German railways has been, as might be expected from these and other economical conditions, incomparably less than that of the railways in other parts of Europe. The following table contains the estimated expense of the construction of those railways brought down to the close of 1847 *: —

	Lines constructed by the State.		Lines constructed by Companies.		Total and Averages.	
	Total Cost.	Cost per Mile.	Total Cost.	Cost per Mile.	Total Cost.	Cost per Mile.
	£	£	£	£	£	£
Completed - - -	10,080,858	12,554	20,507,539	10,722	30,588,397	10,813
In progress - -	16,992,867	14,624	11,335,531	11,613	28,328,398	13,203
Adopted, but not commenced - - -	7,844,844	12,038	6,074,301	9,387	13,919,145	10,715
Contemplated but not adopted - - -	5,828,571	11,631	13,758,676	9,689	19,587,245	10,186
Totals and averages -	40,747,140	13,069	51,676,047	10,197	92,423,187	11,289

It appears from this statement that the capital absorbed by the railways which had been completed up to that period was at the average rate of something less than 11,000*l.* per mile, but it is probable that these lines had not yet absorbed their full amount of capital; and it further appears that the expense of the lines, since constructed, has risen to about 13,000*l.* per mile.

On the 31st of December last there were, as has been already stated, 5342 miles of railway in actual operation in the Germanic States, which, taken at the rate of 12,500*l.* per mile for construction and stock, would have absorbed a capital of 66,775,000*l.*, being a cost amounting to less than one-third per mile of that of the English railways.

* Railway Economy, p. 477.

The expenditure of 30,000,000*l.*, which had been made previously to 1847, had been spread over nine years, being at the average rate of 3,500,000*l.* per annum, 2825 miles of railway having been then completed.

In the four years ending the 31st of December, 1850, 2514 miles of additional lines had been opened, being at the average rate of 629 miles per annum, which, estimated at 12,500*l.* per mile, would give an annual expenditure by the Germanic States of 7,862,500*l.*, being something less than three times the annual expenditure during the preceding nine years.

The sufficiency of single lines of railway for the maintenance of the traffic throughout the Germanic States will at once suggest the fact that the amount of the traffic is small comparatively with that which prevails on the English, and some other continental lines. The mode of working the traffic has generally relation to its amount. On single lines sidings are provided, as in America, at convenient intervals, and trains proceeding in contrary directions run into these, the first which arrives waiting for the passage of the other which is about to meet it. No practical inconvenience arises, the traffic not requiring frequent departures. On the German railways three departures per day for passenger, or two for goods and mixed trains, are generally sufficient. There are no express, or first and second class trains, as in England. Passengers of all classes are indifferently taken in each.

When the German railways were first brought into operation, considerable difficulty was encountered in obtaining the requisite stock of engines and carriages, and agents were despatched to England and the United States to make contracts for the necessary stock. A considerable supply was obtained, and a still greater number ordered. By the end of 1845, 237 engines had been delivered by the principal engine

builders in England, 57 from the United States, 43 from Belgium, and 25 from France. The expense and disadvantage of importing these ponderous machines soon, however, stimulated domestic talent and industry, and there are now established in Germany several factories on a very extensive scale for the construction of engines and carriages, among which may be mentioned those of Messrs. Kessler at Carlsruhe, Hirschau at Munich, the factory of the Vienna and Glognitz railway, that of M. Norris at Vienna, the Weiner and Neustadt factory near Vienna, that of Borsig at Berlin, and several others of minor importance at Berlin, Magdeburg, Aix-la-Chapelle, Chemnitz, &c. Before the end of 1845, 125 engines had been delivered from the German factories, to which a large number has since been added.*

The vehicles for the transport of passengers and goods on the German railways are very various. Passenger carriages, like those of the English and French railways, are occasionally used, as also vehicles like those which we have indicated in a former article as being prevalent in the United States. These carriages measure from 25 to 35 feet in length, and accommodate from 70 to 120 passengers. The goods waggons of like construction are capable of carrying above 12 tons. There are also passenger vehicles on six wheels, and consisting of six compartments; each first class compartment accommodating eight, and each second class ten, passengers.

The proportion of the gross receipts of the German railways proceeding from passengers and goods, is 60 per cent from passengers, and 40 per cent from goods.

One of the most striking differences observable in the passenger traffic on the Germanic railways, compared with that

* Railway Economy, p. 482.

of the English lines, is the proportion which exists between the different classes of passengers. On the English lines nearly 14 per cent of the passenger traffic is first class, 40 per cent second class, and 46 per cent third class. On the German lines, on the other hand, only about 3½ per cent of the passengers are first class, while 74 per cent are third class.

The following are the average fares chargeable per mile upon the German lines:—

First class - - - -	1·62*d.*
Second class - - - -	1·13
Third class - - - -	0·79

The following are the average tariffs per mile for other objects of transport:—

Carriages - - - - -	8·1*d.*
Horses - - - - -	5·0
Cattle, per head - - - -	1·56
Sheep, per head - - - -	0·18
Goods — not classed, per ton - -	6·85
" 1st class - - -	3·47
" 2nd class - - -	2·53
" 3rd class - - -	2·40

It appears from the most recent authentic returns, obtained from the results of nearly 3000 miles of railway, that the average receipts per mile per day amount to about 206*l.*, and that the receipts, taking the cost of construction at 12,500*l.* per mile, are, therefore, 6 per cent on the cost of construction and plant.

It appears, further, that the working expenses are somewhere about 50 per cent of the receipts, which show a net profit on the Germanic railways of 3 per cent.

The average rate of speed on these lines, stoppages included, is 20 miles an hour, the speed in motion being about 24 miles an hour.

Railways in other Countries.

The extent of railway open in other states of Europe bears an extremely insignificant ratio to those which we have already noticed in detail.

Russia, obeying the influence of public opinion, has directed her exertions and capital to the construction of these new lines of communication. An attempt was first made to attract private capital, and especial advantages were offered to those who might undertake the construction of the railways.

The Emperor, besides guaranteeing a *minimum* profit of 4 per cent, proposed to grant gratuitously all the lands of the State that the railway should pass through, and to supply such timber and raw materials necessary for the way and works as might be found upon the spot. It was further proposed to permit the importation of rails and rolling stock free of duty, and Russian proprietors came forward, and not only offered to grant such portion of their land as the railway might pass through gratuitously, but further to dispossess themselves temporarily of their serfs, and surrender them to the use of the companies, on the sole condition that they should be properly supported while employed.

By a ukase, dated February 13. 1842, it was decreed that a railway should be constructed at the expense of the State, uniting St. Petersburgh with Moscow, in order to retain in the hands of the Government a line of communication so important to the industry and commerce of the empire. The

local proprietors agreed to surrender to the Government gratuitously the land necessary for this line.

The system of railways contemplated in Russia, and advancing there with a slow progress, is composed of five principal trunk lines, one of which, connecting Warsaw with Cracow, is completed and in operation, the length being 168 miles; the second will connect Warsaw with St. Petersburgh, the length being 683 miles; the third will connect St. Petersburgh with Moscow. This line, which is now in active progress, will measure about 400 miles. Besides these, permission was given to a company, in 1843, to construct a railway for goods between the Wolga and the Don, the length of which would be 105 miles.

In the actual execution of this magnificent system of railway communication a very inconsiderable progress has yet been made, no lines being opened for traffic except that between Warsaw and Cracow, and a short line connecting St. Petersburgh with Tsarkoé-soélo, which has some analogy to the London and Greenwich railway. The line connecting the Don and Wolga, above-mentioned, was opened in 1846, but this line is exclusively appropriated to merchandise, and is worked by horse power.

In Southern Russia a line of railway is projected between Kief and Odessa, which has been surveyed, but no actual progress yet made in its construction. Lines of railway have also been projected to connect St. Petersburgh with Cronstadt and Baltisleport in Esthonia, to be constructed and worked by a private company, the Government guaranteeing 4 per cent to the shareholders.*

In Italy no extensive system of railways has yet been executed. A few lines diverging from the principal cities,

* Railway Economy, chap. xx.

such as Naples, Milan, Venice, Leghorn, and Florence, are alone in operation.

In the kingdom of Sardinia railways as yet are but prospective. It is proposed, however, to carry two lines from Turin, one directed on Genoa by Alexandria, and the other on Milan by Vercelli and Novara; while a third line, penetrating Mont Cenis by a tunnel, is spoken of.

Having thus briefly sketched the railway communications executed and in progress in different countries where that species of locomotion has been adopted, we shall now bring into juxtaposition the principal results of our calculations, and show the comparative progress which different nations have made in this important art. In making such a comparison it is especially necessary to consider not merely the length of railway, but the capital which has been invested in its construction; for two lines of communication, receiving the common denomination of "railway," may differ from each other extremely in their utility and value. Such a line of communication, for example, as that which connects, or lately connected, Portsmouth, in the state of Virginia, with Weldon, in the state of North Carolina, and that which connects London and Birmingham, both receive the common name of railway, nearly in the same manner as the log cabin of a Missouri settler and Blenheim Palace receive the common designation of dwelling-house. The most exact measure of the relative utility or efficiency of two lines of railway is, therefore, cost. It is not, however, to be forgotten that even in adopting this test, regard must be had to the relative cost of land, material, and labour in different localities.

The extent of railway communication and the expense of its construction may be compared with reference to the population whose commerce it subserves, or to the territorial extent of the country through which it is carried.

In the following table, taken, with some modifications, from the work already noticed, are given, according to the most recently published returns, the population and territory, and the ratio between them, for the several states in which railways have been constructed: —

TABLE showing the Population and Territory, and their relation in the several Countries where Railways have been constructed.

	Population.	Extent of Territory.	Population per Square Mile.
		Square Miles.	
United Kingdom - - -	28,000,000	121,050	231·40
Germanic States, including Denmark and Holland - -	45,753,000	268,548	170·00
United States - - -	24,000,000	3,314,365	7·20
France - - - -	35,400,000	204,708	173·00
Belgium - - - -	4,335,000	11,256	382·00
Russia - - - -	54,000,000	1,892,478	28·60
Italy - - - -	47,600,000	312,774	152·00
Totals and averages - -	239,088,000	6,125,179	39·03

It appears from the official returns that the total length of railway under traffic in the United Kingdom on the last day of 1850 was 6621 miles, which were distributed as follows: —

	Miles.
England and Wales - - -	5,132
Scotland - - - - -	951
Ireland - - - - -	538
Total length - - - -	6,621

The length of railway at that date in progress of construction, consisting of extensions of existing lines, is not ascertained with precision, but was certainly under 1000 miles. Of this a part has, of course, been completed and

brought under traffic since the commencement of 1851. Now, as 625 miles of new line were brought under traffic in 1850, we shall not be far from the truth if we assume that since the commencement of 1851, between 300 and 400 miles more have been completed. This would give a total length of railway of 7000 miles now complete and in operation.

By the returns of the Railway Commissioners it appears that on the 1st day of 1850 the total amount of capital which had been expended on the railways was 220,000,000*l.* sterling. But this sum included a certain unascertained amount absorbed by the railways then in progress, which the commissioners roughly estimated at 20,000,000*l.* This, with another small deduction, left 197,500,000*l.* chargeable to the railways at that date in operation. But, on the other hand, it is to be considered that railways, after they are opened, continue for a considerable time to absorb capital before they attain entire completion. When first opened, stations are imperfectly furnished, some not yet erected; rolling stock is incomplete; depôts for engines and carriages still in progress, and some not yet commenced; turn-plates, sidings, water tanks, coke ovens, and a thousand other accessories, require the lapse of some years to be fully completed and supplied. We shall not, therefore, over-estimate the capital absorbed by the railways open on the 1st of January, 1850, if we leave to its account the amount which the commissioners deducted as representing the capital which had been expended on the railways in progress but not then opened. Thus we shall assume that the railways open on the 1st January, 1850, whose total length amounted to 5996 miles, represent a total capital of 220,000,000*l.*

Allowing a proportional amount of capital for the 1000 miles opened since that date, we shall find that the 7000

miles of railway now open will represent a total capital of 250,000,000*l.*

This result, combined with the calculations and returns given in Dr. Lardner's work*, supplies data from which the following table has been computed: —

Table showing the Extent of Railways under Traffic, and the Amount of Capital invested in them, in the several Countries in which Railways have been constructed.

	Railways completed.	Cost of Construction and Equipment.
	Miles.	£
United Kingdom - - -	7,000	250,000,000
Germanic States - - -	5,342	66,775,000
United States - - -	10,289	66,654,000
France - - - -	1,818	48,781,000
Belgium - - - -	532	9,576,000
Russia - - - -	200	3,000,000
Italy - - - - -	170	3,000,000
Totals - - -	25,351	447,786,000

It must be admitted that we have here sublime results of human industry and enterprise, if sublimity can be applied with propriety to such a class of phenomena.

Within the brief period of twenty years the population of the above named parts of the world, amounting, in aggregate number, to about 240,000,000 of souls, have constructed and brought into operation a length of railway which, if continuously laid, would exactly surround this planet, and have expended in the accomplishment of this work an amount of capital of nearly 448,000,000*l.* sterling.

It appears, also, that there is still in progress a length amounting to about 60 per cent of that which has actually been executed; so that, when the whole shall have

* Railway Economy, p. 496.

been completed, we shall have an entire extent of about 40,000 miles of railway, upon which a capital of 700,000,000*l.* sterling will have been expended.

The gross expenditure made within twenty years being 448,000,000*l.*, is at the average annual rate of 22,400,000*l.*; but as the chief part of this has been expended within the last thirteen or fourteen years, the actual annual expenditure in this period could not have been short of from 27,000,000*l.* to 28,000,000*l.*

The most remarkable feature about this astounding phenomenon is the proportion in which the expenditure of this enormous capital is distributed among the different countries above named. It appears from the above results that 57 per cent of the whole amount is expended in the United Kingdom, while only 15 per cent of it has been expended in the German States, an equal amount in the United States, and 10 per cent in France, insignificant fractions being appropriated to the other states.

But it must be remembered that the expenditure of British capital in these enterprises has not been confined to the United Kingdom. No inconsiderable share of the capital absorbed in foreign railways, not excepting those of the United States, has been derived from this country, and we shall certainly not exaggerate its amount if we assume that 70 per cent of the total capital expended upon the railways of the world have been supplied from the accumulations of British industry! Thus it would appear that within 20 years England has not only paid 250,000,000*l.* sterling for the construction of her own railways, but has contributed somewhere about 50,000,000*l.* to the construction of railways elsewhere.

The net profits realised by the railways in general may be taken at the average amount of 3½ per cent on the cost of

construction and equipment. It follows, therefore, that supposing these annual profits to be re-invested with equal advantage as they become receivable, the capital sunk in the railways of the world, prodigious as it is in amount, and small as is the net profit realised upon it, would be reproduced in the short period of 20 years, and even without such re-investment, and without the influence of compound interest, it would be replaced by the mere passive accumulation of dividends in 30 years.

On comparing the distribution of railway capital with that of population, it appears that for every 100 individuals of the population, the capital expended in railways is as follows : —

United Kingdom	£893
United States	277
Belgium	221
Germanic States	166
France	138
Italy	6
Russia	5

It follows, therefore, that in proportion to its population, the capital expended on railways in the United Kingdom is more than three times the amount expended in the United States, and about five times the amount expended in Belgium.

By a comparison of the length of railway open with the population, we find the following results : —

	Length of Railway per Million of Population.
United States	428 miles
United Kingdom	250 "
Germanic States	116 "
Belgium	123 "
France	51 "
Russia	3·7 "
Italy	3·6 "

It will be observed, that while the total length of railway in operation in the United States exceeds the length open in the United Kingdom in the ratio of 103 to 70, the capital invested in the English railways exceeds that invested in the railways of the United States in the ratio of 125 to 33.

The comparative cost of construction and stock per mile in countries where railways to any considerable extent have been established, is as follows: —

	Cost per Mile for Construction and Stock.
United Kingdom - - - -	£35,700
France - - - - -	26,800
Belgium - - - - -	18,000
Germanic States - - - -	12,500
United States - - - -	6,500

Thus it appears that the average cost per mile of the British railways has been one-third more than the French, twice that of Belgium, three times that of the Germanic, and nearly six times that of the American.

Owing to the want of reliable general data, we are unable to supply an approximate estimate of the average receipts on the American railways.

The following table exhibits approximately the average length of railways under traffic, the gross receipts, and the receipts per mile, during 1850, in the countries of Europe in which this system of locomotion has been to any considerable extent established: —

	Miles under Traffic.	Total Receipts.	Receipts, per Mile.
		£	£
United Kingdom - -	6,400	12,755,000	1,990
Germanic States - -	5,342	5,893,000	1,100
France - - -	1,764	3,770,000	2,130
Belgium - - -	532	891,000	1,670
	14,038	23,309,000	1,670

By comparing these receipts with the average receipts of past years, it appears that since 1848 the receipts per mile on the British railways have decreased from 2774*l.* to 1990*l.*, being 25 per cent, while the receipts on the French lines have augmented in the same interval from 1930*l.* to 2130*l.*, being 11 per cent, and those of the Germanic lines have increased in a still greater ratio.

The traffic returns have supplied the necessary *data* for a near approximation to the net profits on the capital invested, except in the case of the United States, where the financial results are extremely various and uncertain. We have been charged with underrating both the financial value and the mechanical efficiency of the American railways. Nevertheless, we see no reason either to modify our estimates, or to retract the opinions we have expressed. It is quite true that some lines are solidly constructed, and some railways yield 10 or 12 per cent dividends. Nothing in what we have stated is at variance with this; but when we come to spread these high dividends of a few lines over 10,000 miles of railway, the result is greatly modified. It appears from the reports obtained by Dr. Lardner, for 1160 miles of the most active and profitable railways in the States, that the net profit on the capital was 8·6 per cent; but a large proportion of the railways open returned no dividend at all, while a great number of them made small dividends.* It may, perhaps, therefore be assumed, that the American lines, taken one with another, do not yield a net profit of more than one-half that produced by the 1160 miles of railway, the reports of which are given by Dr. Lardner.

In 1848, the expenses on the Belgian and French lines amounted to 63 per cent of the receipts. Since that time

* Railway Economy, p. 403.

the receipts on the Belgian lines have been stationary, but the French have been increased about 11 per cent. It is probable, therefore, that the proportion of expenses to receipts has continued unchanged in the former case, and is somewhat diminished in the latter.

On the Germanic lines the average expenses, as we stated in our article on this subject, appeared, from returns obtained from 3000 miles of railway under traffic, to amount to 48 per cent of the receipts. Since the epoch of the returns to which we then referred, the receipts per mile have increased from 788*l.* to 1100*l.*, being nearly 50 per cent, notwithstanding the greatly augmented length of railway open. This has had, of course, a most favourable effect on the profits, and we may fairly assume that a considerable decrease has taken place in the ratio of the working expenses to the receipts.

To approximate, therefore, to the average profits on the capital invested, we shall assume that the working expenses are 45 per cent of the receipts in the United Kingdom, 63 per cent in Belgium, 60 per cent in France, and 40 per cent in the Germanic States. By comparing the profits arising from the mileage receipts, above stated, with the cost of construction and equipment per mile, we shall obtain the following estimate of the average profits on capital : —

	Per Cent of Capital.		
	Receipts.	Expenses.	Profits.
United Kingdom - - -	5·57	2·51	3·06
United States - - -	—	—	4·30
Belgium - - - -	9·30	5·86	3·44
France - - - -	7·95	4·77	3·18
Germanic States - - -	8·80	3·52	5·28

The estimate here given of the profits of the Germanic lines will be found to be higher than that before given, which referred to a preceding epoch. We have since obtained returns of the traffic to the commencement of 1851, which shows the large increase above stated.

In the case of the United States, the above estimate must be received as a very rough approximation, which, however, we consider not to be *under* the truth.

It appears from the above table, that the average profits on capital invested in the railways of the United Kingdom are lower than in any other country where railways have been constructed and brought into operation.

The following are the average tariffs exacted per passenger per mile: —

United Kingdom - - - -	·54*d.*
United States - - - - -	1·47
Belgium - - - - -	0·80
France - - - - - -	1·03
Germanic States - - - -	0·93

It appears that of the actual number of passengers booked, 47 per cent are third-class passengers in England, 65 per cent in Belgium, 68 per cent in France, and 74 per cent in the Germanic States; while 14 per cent of the passengers are first-class in the United Kingdom, 11 per cent in Belgium, 7 per cent in France, and 3½ per cent in the Germanic States. There is no distinction of classes in the United States.

The number of engines which, upon an average, pass daily over every mile of railway, is — in England 20, in Belgium 18, and in France 14.

The average distance travelled by each passenger booked

is — in England $15\frac{3}{4}$ miles, in the United States $18\frac{1}{3}$ miles, in Belgium $22\frac{6}{10}$ miles, in France 25 miles, and in the Germanic States $19\frac{6}{10}$ miles.

It appears from the preceding calculations, that during the past year 23 millions and one-third sterling have been expended on locomotion by railway in these countries, of which more than the half has been expended within the small compass of our own islands.

Of this amount about 60 per cent has been expended on personal locomotion, and 40 per cent on the transport of goods of every denomination.

The movement of the locomotive engine in executing this traffic has been as follows: —

	Miles run by Engines.
United Kingdom - - - -	40,162,000
Germanic States - - - -	23,572,000
France - - - - -	10,041,000
Belgium - - - - -	4,540,000
Total distance travelled by locomotive engines in 1850 - - -	78,315,000

The engine, therefore, moved over 78,000,000 miles within the year, being at the average rate of 215,540 miles per day, of more than the half of which prodigious amount of locomotion this kingdom was the theatre.

In the performance of this work, the total quantity of coal consumed was a million and three-quarters of tons — a quantity whose cubical bulk would fill a space greater by one-half than the Crystal Palace.

This movement being shared between passengers and goods in the ratio above indicated, we find that the distances moved over by the passengers and goods trains respectively were —

		Miles.
Distance travelled by passenger trains	-	47,000,000
Distance travelled by goods trains	-	31,000,000

Since each passenger train transported on an average 70 passengers, and each goods train 60 tons, it follows that the total locomotion of persons within the year was equivalent to 3,300,000,000 persons carried one mile, and the transport of goods to 1,860,000,000 tons transported one mile.

The number of locomotive engines employed in executing this movement was about 5000, of which 2436 were employed on the British railways, and about 3700 were constructed in England.

VIII.

THE STEAM MARINE.

The world has for the last twenty years been so dazzled with the wondrous results of the application of steam power to land transport by means of iron roads, that the scarcely less important advances which have been made in the same interval in the art of applying the same mighty agent to locomotion over the deep, has received less than its due share of public attention, and has been regarded with less than its due share of admiration.

If the spirits of Watt, Trevithick, and Fulton can look down upon the things of this nether world, and behold the grand results their discoveries and inventions have produced, what triumph must be theirs! For half a century the steam-engine remained a barren fact in the archives of Science, when the self-taught genius of the Glasgow mechanic breathed into it the spirit of vitality, and conferred upon it energies by which it revived the drooping commerce of his country; and when the auspicious epoch of general peace arrived, diffused its beneficial influence to the very skirts of civilisation. Scarcely had the fruit of the labour of Watt ripened, and this great mover been adopted as the principal power in the arts and manufactures, than its uses received that prodigious extension which resulted from its acquiring the LOCOMOTIVE

character. As it had previously displaced animal power in the MILL, and usurped its nomenclature, so it now menaced its displacement on the ROAD. A few years more witnessed perhaps the greatest and most important of all the manifold agencies of steam — that by which it has given wings to the ship, and bade it laugh to scorn the opposing elements, transporting it in triumph over the expanse of the trackless ocean, regardless of wind or current, and conferring upon locomotion over the deep a regularity, certainty, and precision, surpassed by nothing save the movement of chronometers or the course of the heavenly bodies. Such are the vast results which have sprung from the intelligence of men, none of whom shared those privileges of mental culture enjoyed by the favoured sons of wealth; none of whom grew up within the walls of schools or colleges, drawing inspiration from the fountains of ancient learning; none of whom were spurred on by those irresistible incentives to genius arising from the competition of ardent and youthful minds, and from the prospect of scholastic honours and professional advancement. Sustained by that innate consciousness of power, stimulated by that irrepressible force of will, so eminently characteristic of and inseparable from minds of the first order, they, in their humble and obscure positions, persevered against adverse and embarrassing circumstances, impelled by the faith that was in them, against the doubts, the opposition, and, not unfrequently, the ridicule of an incredulous world, until at length, by time and patience, truth was triumphant, and mankind now gathers the rich harvest sown by these illustrious labourers.

It was about the eighth year of the present century that Fulton launched the first steam-boat on the Hudson. After the lapse of four years the first European steam-boat was established on the Clyde. From that time the art of steam

navigation in the two great maritime and commercial nations of the Old and New World advanced with a steady and rapid progress; but it took different directions, governed by the peculiar geographical and commercial circumstances attending the two countries. In America it was applied chiefly to inland navigation — to vessels constructed to traverse with speed, safety, and ease, those rivers and lakes, harbours and extensive inlets, which intersected that vast territory. The problem of steam navigation presented itself to the British engineer under other conditions. While the American was called on to contrive a vessel adapted to smooth water navigation, the British had the far more difficult task to contrive one capable of meeting and surmounting all the obstructions arising from the vicissitudes of the deep.

In the quarter of a century which elapsed between 1812 and 1837, steam navigation made a steady and continuous, but not a sudden progress. The first lines of steamers were established naturally between the ports of England and the nearest sea-ports of Ireland on the one side, and France on the other. The length of each unbroken passage was then regarded as the great difficulty of the project. Thus steamers were established between Holyhead and Dublin, and between Dover and Calais, before projectors ventured to try them between Dublin and Liverpool, or between London and the Low Countries.

After some years' experience, however, and the consequent improvement of the marine engine, passages of greater length were attempted with success. Lines of steamers were established first between more distant parts of the United Kingdom; as, for example, between London and Edinburgh, and between Dublin, Liverpool, and Glasgow. At a later period still longer trips became practicable, and lines of steamers were established between the United Kingdom and the

Mediterranean; touching, however, for fuel at the peninsular ports, such as Corunna, Lisbon, and Gibraltar.

During this period, also, a fleet of steamers was constructed by Government for post-office purposes, and a steam navy was gradually created, among which were found ships of large tonnage and considerable power.

At length, in the year 1836, a project, then considered as a startling one, was first announced, to supersede the far-famed New York and Liverpool packet-ships by a magnificent establishment of STEAM-SHIPS.

The *Sirius* was, we believe, the first steam-vessel which performed this feat; the *Great Western* soon followed, and then came the *President*, the *British Queen*, and other vessels, the names of which are now almost forgotten. A contest arose as to the practicability of the project, not in an absolute, but in a commercial sense. It has been often erroneously affirmed that Dr. Lardner had stated at the meeting of the British Association at Bristol, that to cross the Atlantic by steam was a physical impossibility. By reference to the report published in *The Times* of what took place at that meeting, it will be seen that this statement is erroneous, and that what Dr. Lardner did assert was, that the state of the art of steam navigation at that time was such as to render it impossible that such an enterprise could be conducted in a permanent and profitable manner, unless aided by a subsidy proceeding from the Government. He therefore recommended that the contract for the British Post-office should be first secured, as a necessary condition to commercial success.*

* For a complete exposure and refutation of this widely circulated calumny, see the recently published edition (the eighth) of Dr. Lardner's work on the Steam Engine; published by Taylor, Walton & Co., London, 1851. Most of the matter included in the present review of the Steam Marine has been borrowed from that work.

Eight steam ships, including the *Great Western*, were, soon after the epoch of these debates, placed upon the pro-

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Since the above was in type, the following appeared in the London Journals:—

DR. LARDNER AND ATLANTIC STEAM NAVIGATION.—We have received the following letter from Mr. Bourne, C. E., which sets right the erroneous impression of Dr. Lardner's having stated that the crossing of the Atlantic by a steamer was a physical impossibility:—

London, Nov. 15.

SIR,

IN a new edition of Dr. Lardner's work upon the Steam Engine, which has just appeared, a recapitulation is given of the leading points in the controversy on the subject of Atlantic steam navigation. As the question is thus brought once more before the public, as most erroneous impressions are prevalent respecting it, and as I am able, from my personal knowledge, to state the real facts of the case, I trust you will afford me sufficient space in your columns to set the matter correctly before the public. Most persons suppose that Dr. Lardner declared the passage of the Atlantic, by a steam-vessel, to be a physical impossibility; and if an example be needed to show how far the achievements of physical science may outrun the anticipations of scientific authorities, Dr. Lardner's supposed declaration is usually cited as a case in point. It happens, however, that Dr. Lardner entertained no such opinion as that usually imputed to him, but in fact maintained the very opposite. About the time of the meeting of the British Association in Bristol, in 1837, being then engaged in superintending the construction of the largest steam-vessels of that day—the *Don Juan*, the *Braganza*, and the *Tagus*, belonging to the Peninsular Company—I was applied to by Dr. Lardner to ascertain my views respecting the prospects of Atlantic steam navigation, and I then went with him with some care into the question. It was of course obvious to us both, that for a steam-vessel to cross the Atlantic was perfectly possible. In fact, at least two steam-vessels, the *Savannah* and the *Curaçoa*, had crossed it already; and although it was doubtful whether any steam-vessel of that day could carry coal enough to maintain the full power of the steam during the whole voyage, it was clear, nevertheless, that any sea-worthy steamer could accomplish the voyage by adopting one of two alternatives—she

jected line between England and New York; the *Sirius*, the *Royal William*, the *Great Liverpool*, the *United States*, the

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might either proceed under *full* steam as far as her coals would last, and then conclude the voyage under sails, or she might pass through the whole distance under partial steam, working the engines with only a portion of their power, as had been repeatedly done by the *Medea* and other steam-vessels when sailing with the fleet. It was obvious to every one, indeed, that the capability of a steam-vessel to carry coal for an Atlantic voyage hinged upon the amount of power put into her; or, in other words, it was a question of the proportion of power to tonnage; so that by making the hull of the vessel very large, and the engines relatively small, a sufficient capacity for coal to enable the engines to be worked throughout the voyage would certainly be obtained. This abstract question, however, was not the one which engaged the attention of the public, or upon which it was necessary for Dr. Lardner to deliver any opinion. But three distinct projects were at that time before the public, proposing to connect England with New York by steam-vessels of large tonnage and power; and the problem presented for resolution was, whether these undertakings, unassisted as they were by a government grant, and relying wholly upon the returns from goods and passengers, would probably be successful. Dr. Lardner's opinion was that they would not, and in that opinion I concurred; no one was able to answer Dr. Lardner's arguments, but they were drowned by clamour, and he was represented as having given utterance to an absurdity, in order that the force of his reasonings might be the more effectually concealed. For the moment this expedient succeeded. The three schemes, which had London, Liverpool, and Bristol as their European termini, were, contrary to Dr. Lardner's recommendation, established and tried. The result is exhibited in the following list, which shows the eventual fate of the vessels employed:—*Sirius*, withdrawn; *Royal William*, withdrawn; *Great Liverpool*, sold; *United States*, sold; *British Queen*, sold; *President*, lost; *Great Western*, sold; *Great Britain*, sold. In fact, the whole of the enterprises condemned by Dr. Lardner have miscarried, and have been attended with loss and disappointment to all concerned. The Cunard and American lines of packets, being supported by large government subventions, of course do not come under the conditions Dr. Lardner had to consider, which were those of an enterprise subsisting only on its own returns. Nor had his prognostications any

British Queen, the *President*, the *Great Western*, and the *Great Britain*.

The *Sirius* was almost immediately withdrawn; the *Royal William*, after a couple of voyages, shared the same fate; the *Great Liverpool*, in a single season, involved her proprietors in a loss of 6000*l.*, and they were glad to remove her to the Mediterranean station. The proprietors of the *British Queen*, after sustaining a loss which is estimated at little less than 100,000*l.*, sold that ship to the Belgian government. The *United States* was soon transferred, like the *Great Liverpool*, to the Mediterranean trade. The *President* was lost. The *Great Western*, as is well known, after continuing for some time to make the voyage in the summer months, being laid by during the winter, and after involving her proprietors in a loss of unknown and unacknowledged amount, was sold. Of the *Great Britain* the fate is well known.

Thus it appears, in fine, that after the lapse of nearly fourteen years, notwithstanding the great improvements which took place in steam navigation, the project advanced

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reference to the class of auxiliary screw vessels now plying across the Atlantic — that class of vessels having been unknown in 1836. His remarks had reference exclusively to paddle vessels with full power. And since the whole of the vessels of that class, except those supported by extraneous aid, have been driven from the field, and since the Cunard line, notwithstanding the great ability with which it is conducted, requires a government contribution of 145,000*l.* a year to enable it to be carried on, it appears certain that the doctrines Dr. Lardner promulgated in 1836 and 1837 are irrefragable still, notwithstanding the improvements which have since taken place in steam navigation. One by one the schemes he condemned have exploded. No one would now think of re-constructing them. Who, then, shall say that his anticipations have not been borne out by the result?

J. Bourne.

at Bristol, and there pronounced by Dr. Lardner commercially impracticable, has signally failed.

Meanwhile another project, based upon the conditions indicated by Dr. Lardner as essential to the permanence and success of the enterprise, was started.

Mr. Samuel Cunard, a Canadian, who had extensive experience in maritime affairs, being associated with some large capitalists who had confidence in his sagacity and skill, laid before the British government a project for a line of post-office steamers, to ply between Liverpool and Boston, touching at Halifax. But Mr. Cunard insisted strongly on the necessity of providing a considerable fleet of steamers, to ensure that permanence and regularity which were indispensable to the success of the project. He demonstrated that the magnitude of the capital it must involve, and the vast expenditure attending its maintenance, were such as could not be covered by any commercial returns to be expected from it, and that, consequently, it could only be sustained by a liberal subsidy to be furnished by the government. After much negotiation, it was agreed to grant him an annual subsidy of 60,000*l.*, upon which condition the enterprise was commenced. Mr. Cunard, however, had hardly embarked in it, before it became evident that this grant was insufficient, and it was soon increased to 100,000*l.* per annum. Further experience proved that even this was insufficient to enable Cunard and his associates to maintain the communication in a satisfactory and efficient manner, and the annual subvention was in fine raised to its present amount, that is to say, 145,000*l.* sterling per annum.

Thus supported, the communication is now (1851) maintained throughout the year. During the four winter months, December, January, February, and March, there are two departures per month from each side, and during the eight

other months of the year there is a departure once a week, making a total of forty-four departures from each side, or forty-four voyages going and returning.

These voyages make a total distance sailed of 272,800 geographical miles within the year. The subsidy, therefore, amounts to ten shillings and eight pence per mile sailed.

The present force of the fleet of steamers by which this service is maintained is as follows:—

There are 4 vessels of 800 horse power, and 5 of 500 horse power, making a total of 5700 horse power; there are 2 steamers of 800 horse power each on the stocks, which will soon be in operation, and which will make a total force of 11 vessels, having the aggregate of 7304 horse power.

Thus this great enterprise is now (1851) maintained by a fleet of steamers, the power of which is 7300 horses for the main line, and about as much more for the feeding and subsidiary lines. The subsidy which the enterprise receives from the British government is, therefore, at the rate of nearly 20*l.* per annum per horse power on the main line, and about 13*l.* per annum per horse power upon the whole fleet, feeders and subsidiary lines inclusive.

No official or authorised statement has been published of the financial condition of the Cunard Company. Its proprietors are limited in number, and generally large capitalists, who arrange their interests in private meetings, the results of which are not made public. It seems probable, however, that the enterprise is not highly profitable.

It is certain that the company has been compelled from year to year to augment its capital, either to cover losses incurred, or to give such increased extension to the enterprise as competition forced on it.

To estimate the amount of the capital, let the value of the ships be taken, in round numbers, at 120*l.* per horse power.

Thus, for 11,000 horse power we should have a capital of 1,320,000*l*. To this must be added the furniture, plate, &c., of the ships, the offices, warehouses, stations, &c. at the several ports with which they communicate, the capital engrossed by which, added to the amount just stated, will make a total which cannot fall short of 2,000,000*l*.

It follows, therefore, that this company, after having defrayed its current expenses, must have a balance of about half a million before it can begin to enjoy any net profit; for it has resulted from the general experience in England, both by government and by commercial companies, that besides the current expenses of working a line of steamers, it is necessary to carry yearly to the account of the capital, to cover interest, sinking fund, insurance, &c., a sum equal to 25 per cent of the total capital involved.

Soon after the Cunard line of steamers commenced operations, it was proposed to establish, with government support, a transatlantic line of steamers communicating between the United Kingdom and the West India colonies. An annual grant has been given to this company of 240,000*l*. In fine, all the commercial enterprises for the establishment of lines of steamers, where the voyages are of considerable length, have been supported by government, as appears by the following summary of the grants given to these companies severally:—

The Cunard Company - - -	£145,000
West India Company - - -	240,000
Pacific Company - - - -	40,000
Cape Screw Steam-packet Ship Company -	30,000
Peninsular and Oriental Company - -	219,835
East India Company for the line between Suez and Bombay - - - -	50,000
	£724,835

Thus fostered by government support, the art of steam navigation has made great progress; and within the last ten years especially the marine engine has undergone several important modifications, which were strikingly manifested by the machines exhibited in the Exposition.

The form assumed at first, and long maintained, by the marine engine as used for sea-going vessels, was briefly as follows:—The paddle shaft, extending across the vessel, was kept in revolution by two cranks placed at right angles to each other, so that when either of them was at its dead point the other was in its position of greatest efficiency.

These two cranks were worked in the following manner: —Under each of them, in the hold of the vessel, was placed an engine consisting of a vertical cylinder, in which worked a steam piston; the rod of this piston acted upon a parallel motion, by which its force was transmitted to a pair of beams, placed one at each side of the engine in its lower part; the other ends of these beams were connected by a connecting rod with the crank, the connecting rod being presented upwards. The two engines were precisely counterparts of each other, and placed one at each side of the vessel under the cranks, a gangway being maintained between them for the convenience of the engineer. Nothing can more strongly illustrate the revolution which has taken place in marine engines than the fact, that not one of the numerous marine engines presented in the Exhibition has this form.

In the department appropriated to the moving machinery were placed the marine engines and models exhibited by the firm of Messrs. Maudslay and Field, all of which were kept in motion by steam power.

One of these machines is a double-cylinder engine, consisting of two steam-cylinders, each of half the area necessary

for the intended power. These two cylinders form a single engine, being placed so far apart as to leave a space between them sufficient for the connecting rod. The piston rods are connected together at the top by a cross bar, from the middle of which another bar descends vertically between the cylinders, so as to form, with the cross bar which unites the piston rods, a T. The connecting rod is jointed to the lower end of the tail of the T, and being directed upwards, is jointed at the other end to the crank, which is placed over and between the cylinders. The force of the two pistons is thus directed at once upon a single crank. By this arrangement the simultaneous ascent and descent of the two pistons in the cylinders causes the cross-head to move perpendicularly up and down between the guide bars, thus raising and depressing a slider with the connecting rod, which rod by that means gives rotary motion to the crank and the paddle-shaft. The steam is admitted to and withdrawn from the cylinder by a single slide valve, common to both, through a pipe in the usual way. There is also a narrow passage of communication by which the steam is allowed to pass from one cylinder freely to the other, for the purpose of equalising the pressure.

Engines of this form, which have acquired the name of Siamese engines, have been applied in several steamers, and amongst others in Her Majesty's steam frigate *Retribution.*

It is objected by some authorities that, in this system, there is a greater liability to leakage and increased friction.

If either piston should leak, or if either stuffing-box leak air, a twist must be given to all parts of the engine, arising from the unequal effective action of the two pistons.

It is also objected that the plan involves the necessity of a low condenser, which the air-pump cannot thoroughly drain out; and the pitching of the vessel, by causing the water to

run from one end of the condenser to the other, will occasionally render the working of the air-pump ineffectual, while at other times it is choked with water, which it can only with difficulty deliver, and that fractures are liable to occur in consequence.*

These improvements in the construction of marine steam-engines are especially applicable to those of the larger class, and are intended purposely to produce and apply a greater amount of steam power than has been commonly available within a given space or area on ship-board, and also to obtain a greater length of stroke and connecting rod in a given height than can be obtained in a direct action engine by other means.

Among the advantages of the arrangements are simplicity of construction, more direct action on the crank, and economy of space and material.

It is now about ten years since Messrs. Maudslay and Field first commenced the construction of this form of engine, and in that interval they have made 56 pairs of engines on this principle of the aggregate power of 19,130 horses, giving an average of about 350 horse power each. Several, however, were constructed of 800 horse power.

Another form of marine engine, exhibited by the same house, consists in so arranging the cylinder that a space is left vacant in its centre for the play of the connecting rod, together with its appendages, within the central part of the steam cylinder, and within the central part of the piston which works up and down in the cylinder, and it has for that purpose a small cylinder fixed concentrically with it, the piston being a broad ring or annulus which encompasses the small cylinder, and fits into an annular cylindrical space,

* Lardner on the Steam Engine, 8th edit., p. 268.

which is thus left for the operation of the steam between the interior and exterior cylinders. This annular or ring-shaped piston is moved alternately up and down in this annular space by the force of the steam, but this steam does not enter the small cylinder, which is appropriated altogether to the play of the connecting rod and its appendages. The piston has a T-shaped cross-head, like that described in the last-mentioned engine, and the connecting rod is attached by a pin to the lowest point of this cross-head, and being presented upwards, drives the crank in exactly the same manner as in the engine last described. A model of this machine was seen at work in the Exhibition. This system has also been in operation for about ten years, and twenty-three pairs of engines have been constructed.

The advantages proposed by these improvements are simplicity of construction, more direct action on the crank, economy of space and weight of material, combined with increased area of the piston, whereby a given evaporating power of the boiler is rendered productive, by extended application of the expansive principle, of a greater moving power than in former arrangements. Consequently, under like circumstances, greater power and economy of fuel are obtained, with the further advantage at sea, that when the engine is reduced in its speed, either by the vessel being deeply laden with coal, as is the case at the commencement of a long sea voyage, or by head winds, more steam may be given to the cylinders, and consequently more speed imparted to the vessel, all the steam produced in the boiler being usefully employed.*

Another form of marine engine exhibited by the same firm is the vibrating low-pressure steam-engine, the use of which

* Lardner on the Steam Engine, 8th edit., p. 269.

Messrs. Maudslay and Co. recommend in preference to the old beam-engine, especially in the case of boats requiring a light draught of water. A saving is effected of at least 20 per cent in the weight and expense of machinery, in consequence of the cylinders being placed under the crank shaft, and on the same frame with it, and the connecting machinery, such as cross-heads, slide-rods, beams, parallel motions, and connecting rods, being altogether dispensed with.

It is calculated, also, that there is a saving of half the space usually occupied by the beam-engine.

The cylinder being placed under the crank-shaft causes a great difference in the required strength of the steam-vessel, as the power of the engines in communicating the required rotary motion to the crank shaft is confined to the frame, and does not, as in beam engines, affect the bottom of the vessel.

The difficulty which has usually attended vibrating engines has been obviated in this one, which combines all the efficient parts of the most approved engine, including the application of a D valve or slide, worked by an excentric, by means of which the steam is conveyed to and from the cylinder in the most economical and effective manner. When double engines are employed, as is customary in steam-vessels, an air-pump and condenser are placed in the present case between the two cylinders, the air-pump being worked by a crank shaft, which is connected with the two engines.

The inventors claim for this improvement the advantage of a great reduction of the weight usual in the case of steam-engines as applied to navigation, and a diminution in the expense consequent upon the ordinary wear and tear of the machinery and vessel.

Another form of marine engine, exhibited by Messrs. Maudslay and Field, is their double piston low-pressure

engine, which is more particularly applicable for river navigation, and consists in the adaptation of a piston with two rods working in a steam cylinder of large area, both piston-rods being connected with the same cross-head above, and giving motion to the crank by a single connecting rod. The advantages claimed for this improvement are, that a paddle-shaft applied at a given height above the bottom of the vessel would be enabled to receive a longer stroke of the piston than by any other arrangement, and so a more complete and firm connexion of the cylinder with the crank-shaft bearing is effected, and a cylinder of much greater diameter may be applied, by which the expansive principle may be more fully carried out, and a more direct action of the steam power on the crank obtained with a less weight of materials and a greater economy of space, than has heretofore been attained by any of the arrangements of the marine engine in use. Numerous engines on this principle have been constructed by Messrs. Maudslay and Co. for the shallow navigation of the Rhone, the Indus, and the Sutlej, for which they are particularly well adapted.

Messrs. Maudslay and Field also exhibited an improved screw propeller, applicable with great advantage where auxiliary steam-power is required, since the action can be suspended when the vessel is under sail without taking it out of the water, and without, at the same time, interfering with the sailing or steering of the vessel. The blades of the propeller are connected together in such a manner, that by moving one the other assumes a corresponding position, and presents either the proper angle for propulsion, or lies fore and aft with the keel, so as to offer the least possible resistance to the vessel's progress when steam-power is dispensed with.

This propeller offers great advantages to vessels making

long voyages with a small stock of fuel, and in which steam is used as an auxiliary power, as when the wind is not fair for the use of sails. With a propeller of this description, not a single moment need be lost in the change from sailing to steaming or from steaming to sailing, and, consequently, no more fuel need be expended than is absolutely required.

Messrs. Penn and Son, of Greenwich, exhibited a most beautiful and interesting collection of engines and models, among which the first to attract attention was a pair of small oscillating marine engines, whose combined power is that of 24 horses. The advantages claimed for this machine are simplicity and lightness of structure, the parts being few, and the action of the pistons on the crank being most direct. Their gross weight, including the supply of water for the boiler, does not exceed 9 cwt. per nominal horse power. Messrs. Penn and Son have already manufactured 200 pairs of these engines, among which are two placed on board Her Majesty's steam yacht *Fairy*, the Admiralty yacht *Black Eagle*, and many of the Post-Office and war steamers. A pair of engines of this construction of 500 horse power were lately in process of construction for the *Great Britain* steam ship.

Messrs. Penn and Son also exhibited a pair of patent trunk engines for driving the screw propeller by direct action without the intervention of cogged wheels. In this arrangement, the connecting-rod is directly jointed on to the piston itself, and the angular strain is taken by trunks or pipes, passing out of each end of the cylinder, cross-heads and all other complicated apparatus being dispensed with.

The air-pumps are double-acting, and worked by a straight rod from the piston to the plunger, the feed-pumps being similarly worked.

Engines on this principle have been fitted on board Her

Majesty's screw frigates *Arrogant* and *Encounter*, the former making 60 and the latter 80 revolutions per minute. The power of each of these machines is 360 horse.

Messrs. Penn and Son also exhibited a model of their oscillating engines of 500 horse power placed on board Her Majesty's steam frigate *Sphinx*, and a model of the engine of 32 horse power placed in one of the Thames steamers, showing the mechanical wheel with feathering floats.

The council medal has been granted to Messrs. Penn, for their adaptation of marine engines to vessels of small tonnage.

The same engineers exhibited an auxiliary or feed-engine, to pump water into the boilers of steam-vessels when the large engines are not at work, or in the contingency of the ordinary feed-pumps being deranged.

Mr. Atherton exhibited a new form of marine steam-engine, applicable either to the paddle-wheel or the screw propeller. The object of this engine, according to the inventor, is to simplify the construction of the marine sway-beam engine, and, as compared with the ordinary construction of side lever-engines, he claims the following advantages:—1. That it occupies less width; 2. That, being in a central position and connected directly with the piston and cranks, various cross strains are avoided, and it is not so liable to breakage, and the probable extent of damage consequent on any is greatly diminished; 3. The cross-head, cross-tail, and various parts are entirely suppressed, and consequently all the parts of the engine are more accessible and more easily cleaned when in operation: in fine, the engine is nearly balanced by means of two air-pumps, one on each side of the main centre, and is therefore less liable than marine engines generally to be brought up in a heavy sea. The steam slides are so proportioned and adjusted as not to close the exhausting port till after the turn of the stroke, thereby

obviating the danger of breakage by water in the cylinder, and suppressing the escape valves. The expansive gear operates with precision, whatever be the speed of the engine, and supplies self-acting means of regulating the expansive working of the machine.

The inventor, Mr. Charles Atherton, who is chief engineer of the Royal Dockyard, Devonport, exhibited this machine to illustrate the practicability of steam fleets, both commercial and national, being fitted with engines of different construction, and of a classified gradation of sizes, whereby it is calculated that ten different sizes only would meet all the requirements of steam marine service now employing in Great Britain upwards of 1000 different sizes and constructions.

Mr. Smith exhibited a most interesting collection of models and drawings illustrative of the history of screw steam navigation, showing the progressive changes which have been made in the screw propeller from the date of its first application to the present time. We must here, however, observe, that the screw propeller, in the form which it has now at length assumed, appears to us to differ in nothing which is at all essential from the propeller invented and patented by Captain John Ericsson, which has been in extensive operation for several years in the United States. We may even go further, and say that Captain Ericsson's arrangements are attended with an advantage which we did not find in any of the models of screw propellers exhibited in the Exhibition, but it would be inconsistent with our limits here to discuss this question upon its merits.

Propellers on Ericsson's principle have been for several years in extensive operation in the inland steam navigation of the United States. In the line of navigation between Chicago and Quebec alone, there were fifty vessels thus propelled

in 1849, and about as many more in other parts of the Union.

It will be apparent that this, as well as every other submerged propeller, has the advantage of producing the same propelling effect, whatever position may be given to it in the water. However the ship may pitch or roll, or however unequal the surface of the sea may be, such a propeller will always produce the same backward current without any variation of effect.

The circumstances which prevent the co-operation of the power of steam with that of the sails in steam-vessels propelled by the common paddle-wheels, will not operate with submerged propellers, inasmuch as their effect is altogether independent of the careening of the ship.

But though this defect is remedied, the submerged propellers in general are still subject to objections to which even the common paddle-wheel is not obnoxious. Being permanently submerged, and liable to accidental fracture, and derangement from various causes, they are inaccessible, and cannot be repaired at sea. But, besides this, when the object in view is to take full advantage of the power of the sails at times when it is expedient to suspend the action of the machinery, the submerged propeller becomes an obstruction, more or less considerable, to the progress of the vessel. An expedient was some years since invented and patented by Captain Ericsson, and applied on board several vessels in the United States, for the removal of this inconvenience. By this contrivance, the commander was enabled at any time, within the space of ten minutes, to raise the propeller out of the water, or, being so raised, to submerge it so as to convert for all intents and purposes, a steamer into a sailing vessel, or a sailing vessel into a steamer, as he may see fit.

The shaft on which the propelling wheel is fixed is provided with a simple mechanism within the vessel, by which

it may be easily at any time drawn out of the nave of the wheel. The wheel itself is sustained by a powerful vertical arm, the upper end of which is attached to a strong axis, which enters the vessel parallel to the main axis, and above the summit of the wheel. To this axis, within the vessel, is attached a piece of mechanism, by which it may be turned through half a revolution by the power of two men, with such force that the propeller will be made to perform half a revolution round the upper end of the vertical arm, and may thus be raised out of the water.

Great as the progress of steam navigation has been within the last quarter of a century, much still remains to be accomplished before that vast agent of transport can be regarded as having been pushed to the limit of its powers. Its superior speed, regularity, and certainty, comparatively with sailing vessels, have naturally first attracted to it passengers, despatches, and certain descriptions of merchandize to which expedition is important and which can bear a high rate of freight. The mechanical conditions which ensure expedition in long voyages, exclude, to a great extent, the transport of general merchandize; for a large part of the tonnage of the vessel is occupied by the machinery and fuel. The heavy expenses, therefore, of the construction and maintenance of these vessels, must be defrayed by appropriating the profitable tonnage to those objects of transport alone which will bring the highest rate of freight. While the steamer, therefore, has allured from the sailing vessel the chief part of the passenger traffic, the mails altogether, parcels, and some few objects of general traffic, the latter still continues in undisturbed possession of the transport business of general commerce.

The next step in the improvement of the art must therefore be directed to the construction of another class of steam-vessels, which shall bear to the present steam ships the same

relation which the goods trains, on the railway, bear to the passenger trains. As in the case of these goods trains, expedition must be sacrificed to reduce the cost of transport to the limit which shall enable the merchandize to bear the freight. If the steamer for the general purposes of commerce can be made to exceed the sailing vessel, in any thing approaching to the ratio by which the goods train on the railway exceeds the waggon or canal boat, we shall soon see the ocean covered with such steamers, and the sailing vessel will pass from the hands of the merchant to those of the historian.

To render steamers capable of attaining these ends, it will be evidently advisable to adopt measures to combine the qualities of a sailing vessel with those of a steamer. The ships must possess such steaming power as may give them that increased expedition, regularity, and punctuality, which, in the existing state of the art, can only be obtained through that agency; but it is also important that they accomplish this without robbing them, to any injurious extent, of their present capability of satisfying the wants of commerce.

No expedient appears so likely to accomplish this, in the present condition of the art, as one which would have for its object the removal of the paddle-wheels now generally used, and the substitution of some description of subaqueous propeller. A great reduction in the dimensions of the machinery, and the surrender to the uses of commerce of a large share of that valuable space which it now occupies within the vessel, are also essential. It is incumbent on the engineer who assumes the high responsibility of the superintendence of such a project, to leave the ship in the full and unimpaired enjoyment of its functions as a sailing vessel. Let him combine, in short, the agency of steam with the undiminished nautical power of the ship. Let him celebrate the

marriage of the steam engine with the sailing vessel. If he accomplish this with the skill and success of which the project is susceptible, he may fairly hope that his name will go down to posterity as a benefactor of mankind, united with those of Fulton and Watt.

The actual progress of mechanical science encourages us to hope that the day is fast approaching when such ideas will be realised; when we shall behold a great highway cut across the wide Atlantic, not as now subserving to those limited ends, the attainment of which will bear a high expense, but answering all the vast and varied demands of general commerce. Ships which would serve the purposes we have here shadowed out, can never compete in mere speed with vessels in which cargo is nothing, expense disregarded, and expedition every thing. Be it so. Leave to such vessels their proper functions; let them still enjoy, to some extent, the monopoly of the most costly branches of traffic, subsidised as they are by the British Treasury; and let the commercial steam ships, securing equal regularity and punctuality, and probably more frequent despatch, be content with somewhat less expedition. This is consistent with all the analogies of commerce.

There is another consideration which ought not to be omitted. In all great advances in the arts of life, extensive improvements are at first attended with individual loss, of greater or less amount. The displacement of capital is almost inevitably attended with this disadvantage. It is the duty, therefore, of the scientific engineer, in the arrangement and adoption of his measures, to consider how these objects may be best attained with the least possible injury to existing interests. To accomplish this will not only be a benefit to the public, but will materially facilitate the realisation of his own objects, by conciliating in their favour those

large and powerful interests whose destruction would be otherwise menaced by them. If, then, in the present case, it is found practicable with advantage to introduce into the present sailing ships, more especially into those most recently constructed, the agency of steam, a very important advantage will be gained for the public, and the almost unanimous support and countenance of the commercial community will be secured.

To attain the objects here developed, it will be evidently indispensable to remove those impediments which at once disfigure the appearance and destroy the efficiency of the sailing qualities of the ship by the enormous and unsightly excrescences projecting from the sides in the shape of paddle-wheels, and the wheel-houses or paddle-boxes, as they are called. These appendages are attended with many evils, the least of which is perhaps the impediment which they present to the progress of the ship.

But the form, magnitude, and position of the propelling machinery, is far from being the only obstacle to the full success of the present steam vessels when directed to the general purposes of commerce. The engines themselves, and the boilers, from which the moving power proceeds, and the fuel by which they are worked, occupy the very centre of the vessel, and engross the most valuable part of the tonnage. The chimney, which gives efficacy to the furnaces, is also an unsightly excrescence, and no inconsiderable obstruction.

When long ocean-voyages are contemplated, such as those between New York and the ports of England, there is another serious obstacle, which is especially felt in the westward trip, because of the prevalence of adverse winds. When the vessel starts on its long voyage, it is necessarily laden with a large stock of fuel, which is calculated to meet, not merely the average exigencies of the voyage, but the utmost

extremity of adverse circumstances of wind and weather to which it can by possibility be exposed. This fuel is gradually consumed upon the voyage; the vessel is proportionally lightened, and its immersion diminished. If its trim be so regulated that the immersion of its wheels at starting be such as to give them complete efficiency, they may, before the end of the voyage, be almost if not altogether raised out of the water. If, on the other hand, the efficiency of propulsion in the latter part of the voyage be aimed at, they must have such a depth at its commencement as to impair in a serious degree their propelling effect, and to rob the vessel of its proper speed. Under such circumstances, there is no expedient left but compromise. The vessel must start with too great and arrive with too little immersion. There is no alternative, save to abandon altogether the form and structure of the present machinery, and to awaken the inventive genius of the age to supply other mechanical expedients which shall not be obnoxious to these objections.

In fine, then, we look to the improvement of auxiliary steam power, and the extended use of submerged propellers, such as those invented by Captain Ericsson, or the screw, as the means which, in the existing state of the art of steam navigation, are most likely to extend the benefits of that agent of transport to general commerce. In long voyages, steam power need only be used in calms or against unfavourable winds. The vessel deriving such aid from steam will gain sufficient advantage over sailing vessels to secure a preference for freight, and the machinery and fuel will be so reduced in bulk as to encroach on the tonnage of the ship to no very injurious extent.

If the present form and structure of steam-vessels be obnoxious to these many serious objections when considered

with reference to the purposes of general commerce, they are still more objectionable when considered with reference to the purposes of national defence. It is undoubtedly a great power with which to invest a vessel-of-war, to be able to proceed at will, in spite of the opposition of wind or tide, in any direction which may seem most fit to its commander. Such a power would have surpassed the wildest dreams of the most romantic and imaginative naval commander of the last century. To confer upon the vessels of a fleet the power immediately, at the bidding of the commander, to take any position that may be assigned to them relatively to the enemy, or to run in and out of a hostile port at pleasure, or fly with the rapidity of the wind, past the guns of formidable forts before giving them time to take effect upon them—are capabilities which must totally revolutionise all the established principles of naval tactics. But these powers at present are not conferred upon steam ships without important qualifications and serious drawbacks. The instruments and machinery from which they are immediately derived are, unfortunately, exposed in such a manner as to render the exercise of the powers themselves hazardous in the extreme. It needs no profound engineering knowledge to perceive that the paddle-wheels are eminently exposed to shot, which, taking effect, would altogether disable the vessel, and leave her at the mercy of the enemy; and the chimney is even more exposed, the destruction of which would render the vessel a prey to the enemy within itself in the shape of fire. But besides these most obvious sources of exposure in vessels of the present form intended as a national defence, the engines and boilers themselves, being more or less above the water-line, are exposed so as to be liable to be disabled by shot.

A war steamer, to be free from these objections, should be propelled by subaqueous apparatus. Her engines, boilers, and all other parts of her machinery should be below the water-line. Her fuel should be hard coal, burning without visible smoke, so that her approach may not be discoverable from a distance. Her furnaces might be worked by blowers, so that the chimney might be dispensed with, and thus its liability to be carried away by shot removed.

The policy of the British government has been to rely on the commercial steam navy, as a means of national defence in the event of the sudden outbreak of war. By the evidence given before a committee of the House of Commons in 1850, and the report founded thereupon, it appeared that commercial steamers in general are capable of war service, with no other previous alteration or preparation than such as are easily practicable and expeditiously executed. It was shown that all steamers of 400 tons and upwards would be capable, with some additional strengthening, to carry such pivot guns as are used in war steamers, and that there are few mercantile steamers of any size which might not carry an armament such as would render them useful in case of an emergency.

By a return contained in the same report, it appeared that on the 1st of January, 1849, the number of commercial steamers registered was 1110, consisting of the following, classed according to their tonnage: —

Under 101 tons - - - - -	529
From 101 to 250 tons inclusive - -	272
" 251 " 400 " - - -	136
" 401 " 600 " - - -	71
" 601 " 1000 " - - -	67
Above 1000 - - - - -	35
Total - - - - -	1110

The total power of these vessels was estimated at 92,862 horses, and the total tonnage was 255,371 tons.

There were ten vessels of the largest class then in process of construction, and which (besides others) have since been completed. We shall, therefore, not overrate the number, power, and tonnage of the present commercial steam navy, if we estimate it at 1150 vessels, having the total power of 110,000 horses, and the total tonnage of 275,000 tons.*

* Lardner's Steam Engine, 8th ed. p. 308.

IX.

THE TIMES PRINTING MACHINE.

To appreciate the merits of this extensive piece of machinery, let us revert for a moment to those printing presses with which the memory of all who have been as long connected with the press as we are must be still familiar.

In the process of printing a sheet of paper, there are several distinct operations to be executed. The types which have been previously put together and arranged in a strong frame, called a "form," which corresponds in magnitude with the sheet to be printed, are laid upon a flat horizontal metallic table, with their faces upwards. There are then the following operations to be executed:—1st, printing-ink is to be applied to the faces of the type, so evenly that there shall be no blotting or inequalities in the printing; 2nd, the sheet of paper to be printed must be laid upon the form so as to receive the impression of the type in its proper position, and in the centre of it; 3rd, this paper must be urged upon the type by a sufficient pressure to enable it to receive the printed characters, such pressure, however, not being so great as to cause the type to penetrate or deface the paper; 4th, the paper is, in fine, when thus printed, to be withdrawn from the type and laid upon a table, where the printed sheets are collected.

In the old process these operations were executed by two men, one of whom was employed to ink the types, and the other to print. The former was armed with two

bulky inking balls, consisting of a soft black substance of leathery appearance, spherical form, and about 12 inches in diameter. He flourished these with dexterity, dabbed them upon a plate smeared with ink, and then with both hands applied them to the faces of the types until the latter were completely charged with ink. This accomplished, the other functionary — the pressman, — having prepared the sheet of paper while the type was being inked, turned it down upon the type, drew it under the press, and with a severe pull of the lever gave the necessary pressure by which the paper took the impression of the type. A contrary motion of the apparatus withdrew the type from under the press, and the pressman, removing the paper, now printed, deposited it upon a table placed near him to receive it. The same series of operations was then repeated for producing the impression of another sheet, and so on. In this manner two men in ordinary book work usually printed at the rate of 250 sheets per hour on one side, but in the case of some of the daily journals the rate was raised to from 350 to 400.

One of the first improvements which took place upon this apparatus consisted in the substitution of a cylindrical roller for the inking balls. This roller was mounted with handles, so that the man employed to ink the type first rolled it upon a flat surface smeared with ink, and having thus charged it, applied it to the type form, upon which he rolled it in a similar manner, thus transferring the ink from the roller to the faces of the type. The substitution of these inking rollers for the inking balls constituted one of the most important steps in the modern improvement of the art of printing. The rollers were composed of a combination of treacle and glue, and closely resembled caoutchouc in their appearance and qualities.

After these followed, year by year, a rapid succession of

improvements, by which the processes of inking and printing were, as is usual in the progress of manufactures, transferred one by one, from the human hand to the more untiring and unerring action of machinery. The improved printing-presses assumed a variety of forms according to the purposes to which they were applied, and to the rate at which they were required to work.

Their most general form is represented in *fig.* 1., which will convey a sufficiently clear idea of the principle on which they were constructed.

A frame, on which was fixed the type form and inking table, was placed upon an horizontal table A, B, upon which it was moved alternately from right to left and from left to right, by steam power. The inking table was constantly smeared with ink by means of a roller C, called the "ductor roller," under which it was moved. This frame, thus carrying the types and the inking table, and moved by machinery backwards and forwards alternately through a certain distance, was placed under a cylinder or drum D, upon which was stretched, by means of tapes, the paper to be printed, the tapes passing over those parts of the paper which corresponded with the margins of the sheet. The inking rollers were also placed over this frame, so that by its motion under them the inking table, first receiving ink from the ductor roller, then diffused it upon the inking rollers.

By each motion of the table backwards and forwards from A to B, and from B to A, the type form was first made to pass under the inking rollers, by which means the faces of the types were coated with ink, and was next made to pass under the cylinder D, on which the paper was extended, which, being pressed upon them, their impression was left upon the paper. While the types thus passed under the paper cylinder, that cylinder revolved in contact with them in accordance

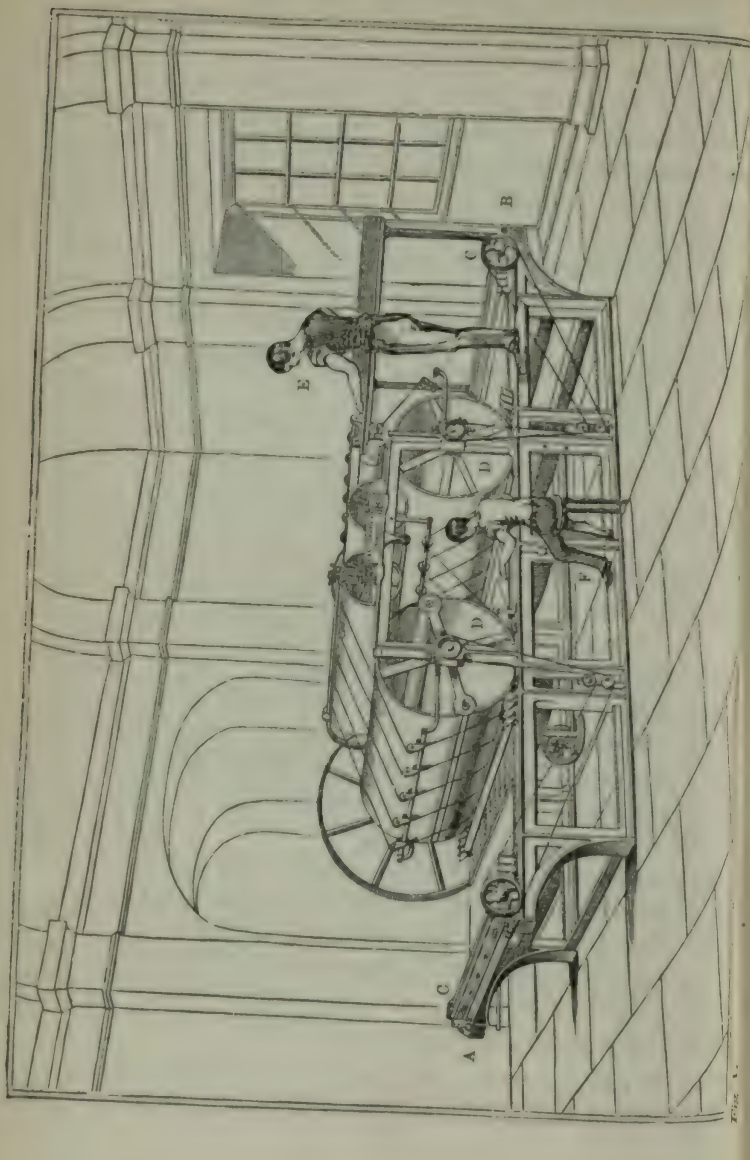


Fig. 1.

with their motion, and each time it thus passed over them a sheet of paper was printed.

It will thus be understood that by each alternate motion of the frame which carried the type and the inking table, four distinct operations were performed. First, the inking table received a supply of ink from the ductor roller; secondly, it delivered and diffused a corresponding quantity of ink over the inking rollers; thirdly, these rollers spread an equal quantity of ink over the surface of the type; and, fourthly, the types gave their impression to the sheet of paper extended upon the drum or cylinder, and accomplished the operation of printing.

A boy, called the "layer on," E, standing at an elevated desk, delivered the sheet to the fingers of the machine, which, laying hold of it, drew it under the tapes, by which it was carried round with the cylinder, pressed on the types, printed and delivered to the "taker off," F, placed at the lower desk.

According to the arrangement represented in the figure, the sheet would be printed on both sides in a single operation. The sheet is carried by the tapes round one cylinder, then over and under two wooden drums to the other cylinder. In its progress, the sheet is turned over, receiving one printed impression on one side from the first form, and the second impression on the other side from the second form.

This represents what is called a "book machine," but the principle is the same as that of the newspaper machine, in which there is but one printing cylinder and one type form.

The first machines on this improved principle which were brought into operation on a large scale were erected at the printing-office of *The Times*, and it was announced in that journal on the 28th November, 1814, that the sheet which was then placed before the reader, was the first ever printed by self-acting and steam-impelled machinery.

By this improvement, the effective power of the printing press was augmented in a very high proportion. With the hand-presses previously in use, not more, as we have seen, than 250 sheets could be printed on one side in an hour. Each of the two machines erected at *The Times* office produced 1800 impressions per hour.

These machines were the work of Mr. Kœnig, who also, about the same time, made machines for Mr. Bensley, capable of printing 1200 sheets per hour on both sides, which were soon afterwards improved by Mr. Applegath, and rendered capable of printing at the rate of 2400 sheets per hour perfect.

Machines adapted to print in a single operation the same sheet on both sides have been usually called "book machines," while those which print on one side only are called "newspaper machines."

In the practical management of newspapers, it is found convenient so to arrange the letter-press that the matter appropriated to one side of the sheet shall be ready for press at an early hour, and may be printed before the contents of the other side, in which the most recent intelligence is included, can be prepared. Hence the advantage of using machines adapted to print one side only with the most extreme celerity for newspapers.

Although the power of the printing-press, thus improved, was increased in an eightfold proportion as compared with the former hand-presses, many years had not elapsed before it proved to be still insufficient. The exigencies of the press demanded even a greater expedition. The circulation of *The Times*, in particular, underwent so great an increase, as to impose upon its managers the necessity of providing means by which they might be enabled to throw off at need

4000 printed sheets per hour, or rather more than one sheet per second.

To accomplish this with a single form of type would require that in each second all the four operations above mentioned should be executed with that form; that is to say, the ink must be spread upon the inking table by the ductor roller, transferred to the inking rollers, and by them spread upon the type, and, in fine, the types impressed upon the paper, and the paper delivered printed, all within one second.

This formidable mechanical problem was solved by introducing four printing cylinders instead of the two previously employed. This increased power, moreover, was obtained without departing materially from the principle of the machine already explained. The type form and inking table were still retained, moving backwards and forwards alternately under the paper cylinders and inking rollers, but the number of cylinders and rollers under which they were moved was augmented. As there were now four cylinders on which paper was extended to be printed, there were three sets of inking rollers. Every time the type form was carried from right to left, or from left to right, by the alternate motion, the types were twice inked and twice delivered their impression to the paper, and, consequently, two sheets were printed, the returning motion of the frame printing two sheets more.

This machine, which when first produced was regarded as almost miraculous in its powers, was erected at *The Times* office in 1827, and immediately invested the proprietors of that journal with the power of printing at the rate of between 4000 and 5000 sheets per hour. The apparatus was attended by eight persons, four "layers on," who stood at four delivery tables, and four "takers off," stationed at four receiving

tables. A sheet was delivered to the machine by each of the former, and seized between two fingers, which drew it between the tapes, by which it was carried round the printing cylinder, brought into contact with the types, impressed upon them, carried out, and delivered printed to each of the latter, all this being executed by self-acting machinery. The same process was performed by each of the four cylinders, during each motion of the frame, carrying the type and inking table in the one direction and in the other.

This machine continued to serve the purposes of *The Times* newspaper until within a few years, when again the exigencies of the press exceeded even its immense powers, and another appeal was made to the inventive genius of Mr. Applegath. It was, in short, necessary to provide a machine by which *at least* 10,000 *sheets an hour could be worked off from a single form!*

In considering the means of solving this problem, it is necessary to observe, that whatever expedient may be used, the sheets of paper to be printed must be delivered one by one to the fingers of the machine by an attendant. After they once enter the machine they are carried through it and printed by self-acting machinery. But in the case of sheets so large as those of the newspapers, it is found that they cannot be delivered with the necessary precision by manipulation at a more rapid rate than two in five seconds, or twenty-five per minute, being at the rate of 1500 sheets per hour. Now, in this manner, to print at the rate of 10,000 per hour, would require seven cylinders, to place which so as to be acted upon by a type form moving alternately in a horizontal frame, in the manner already described, would present mechanical difficulties almost insurmountable.

In the face of these difficulties, Mr. Applegath, to whom

the world is indebted for the invention of *The Times* printing machine, decided on abandoning the reciprocating motion of the type form, arranging the apparatus so as to render the motion continuous. This necessarily involved circular motion, and accordingly he resolved upon attaching the columns of type to the sides of a large drum or cylinder, placed with its axis vertical, instead of the horizontal frame which had been hitherto used. A large central drum is erected, capable of being turned round its axis. Upon the sides of this drum are placed vertically the columns of type. These columns, strictly speaking, form the sides of a polygon, the centre of which coincides with the axis of the drum, but the breadth of the columns is so small compared with the diameter of the drum, that their surfaces depart very little from the regular cylindrical form. On another part of this drum is fixed the inking table. The circumference of this drum in *The Times* printing machine measures 200 inches, and it is consequently 64 inches in diameter.

The general form and arrangement of the machine are represented in *fig.* 2., where D is the great central drum which carries the type and inking tables.

This drum in *The Times* machine is surrounded by eight cylinders, R, R, &c., also placed with their axes vertical, upon which the paper is carried by tapes in the usual manner. In the machine in the Exhibition, the number of cylinders was only four, but the principle is the same. Each of these cylinders is connected with the drum by toothed wheels, in such a manner that their surfaces respectively must necessarily move at exactly the same velocity as the surface of the drum. And if we imagine the drum thus in contact with these eight cylinders to be put in motion, and to make a complete revolution, the type form will be pressed successively against each of the eight cylinders,

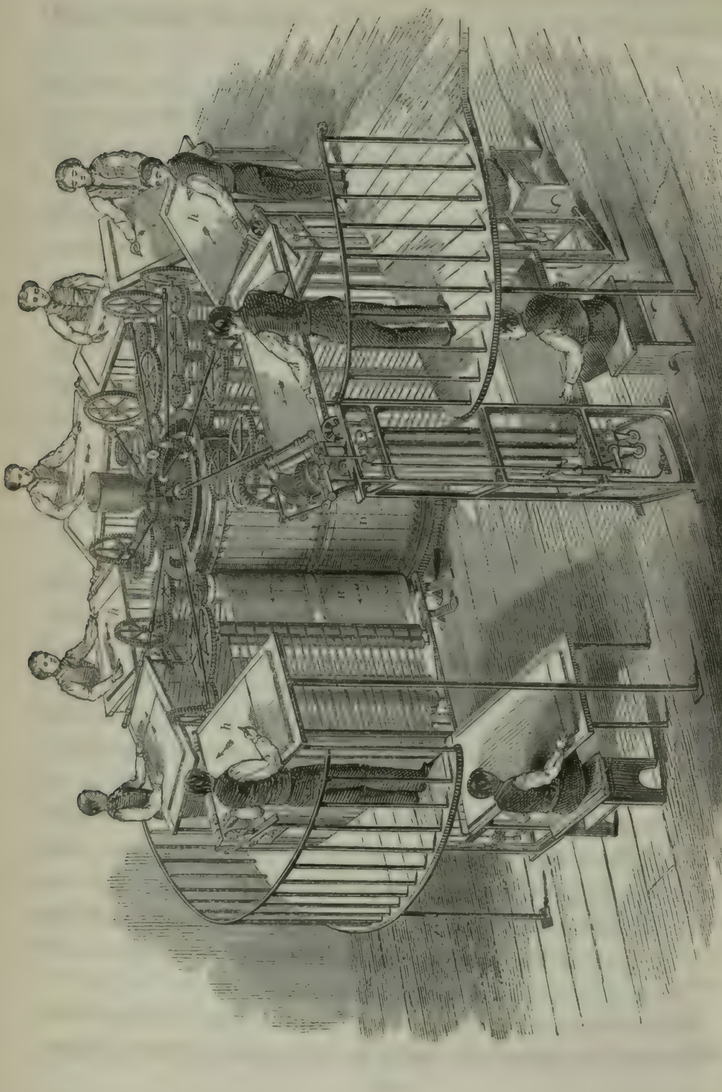


Fig. 2.

and if the type were previously inked, and each of the eight cylinders supplied with paper, eight sheets of paper would be printed in one revolution of the drum.

It remains, therefore, to explain, first, how the type is eight times inked in each revolution; and, secondly, how each of the eight cylinders is supplied with paper to receive their impression.

Beside the eight paper cylinders are placed eight sets of inking rollers; near these are placed two ductor rollers. These ductor rollers receive a coating of ink from reservoirs placed above them. As the inking table attached to the revolving drum passes each of these ductor rollers, it receives from them a coating of ink. It next encounters the inking rollers, to which it delivers over this coating. The types next, by the continued revolution of the drum, encounter these inking rollers, and receive from them a coating of ink, after which they meet the paper cylinders, upon which they are impressed, and the printing is completed.

Thus in a single revolution of the great central drum the inking table receives a supply eight times successively from the ductor rollers, and delivers over that supply eight times successively to the inking rollers, which, in their turn, deliver it eight times successively to the faces of the type, from which it is conveyed finally to the eight sheets of paper held upon the eight cylinders by the tapes.

Let us now explain how the eight cylinders are supplied with paper. Over each of them is erected a sloping desk, *h*, *h*, &c., upon which a stock of unprinted paper is deposited. Beside this desk stands the "layer on," who pushes forward the paper, sheet by sheet, towards the fingers of the machine.

These fingers, seizing upon it, first draw it down in a vertical direction between tapes in the eight vertical frames,

until its vertical edges correspond with the position of the form of type on the printing cylinder. Arrived at this position its vertical motion is stopped by a self-acting apparatus provided in the machine, and it begins to move horizontally, and it is thus carried towards the printing cylinder by the tapes. As it passes round this cylinder it is impressed upon the type, and printed. It is then carried back horizontally by similar tapes on the other side of the frame, until it arrives at another desk, where the "taker off" awaits it. The fingers of the machine are there disengaged from it, and the "taker off" receives it, and disposes it upon the desk. This movement goes on without interruption; the moment that one sheet descends from the hands of the "layer on," and being carried vertically downwards begins to move horizontally, space is left for another, which he immediately supplies, and in this manner he delivers to the machine at the average rate of two sheets every five seconds, and the same delivery taking place at each of the eight cylinders, there are 16 sheets delivered and printed every five seconds.

It is found that by this machine in ordinary work between 10,000 and 11,000 per hour can be printed; but with very expert men to deliver the sheets, a still greater speed can be attained. Indeed, the velocity is limited, not by any conditions affecting the machine, but by the power of the men to deliver the sheets to it.

In case of any misdelivery a sheet is spoilt, and, consequently, the effective performance of the machine is impaired. If, however, a still greater speed of printing were required, the same description of machine, without changing its principle, would be sufficient for the exigency; it would be necessary that the types should be surrounded with a greater number of printing cylinders.

The machine erected in the Exhibition, and which is the

property of Mr. Ingram, was intended for the *Illustrated London News*, — a journal, as is well known, of large circulation, and attended with a circumstance which gives interest to its application in this case, inasmuch as the style of printing requires greater accuracy of workmanship than common letter-press, in consequence of the number and artistic excellence of the wood engravings.

The great central cylinder is in this case surrounded by only four printing cylinders, each superintended by two men.

It may be right to observe, that these surrounding cylinders and rollers, in the case of *The Times* machine, are not uniformly distributed round the great central drum; they are so arranged as to leave on one side of that drum an open space equal to the width of the type form. This is necessary in order to give access to the type form so as to adjust it.

In a machine where the number of type cylinders is not so crowded round the drum, this precaution is not necessary.

One of the practical difficulties which Mr. Applegath had to encounter in the solution of the problem, which he has so successfully effected, arose from the shock produced to the machinery by reversing the motion of the horizontal frame, which in the old machine carried the type form and inking table, a moving mass which weighed a ton! This frame had a motion of 88 inches in each direction, and it was found that such a weight could not be driven through such a space with safety at a greater rate than about 45 strokes per minute, which limited its *maximum* producing power to 5000 sheets per hour.

Another difficulty in the construction of this vast piece of machinery, was so to regulate the self-acting mechanism that the impression of the type form should always be made in the centre of the page, and so that the space upon the paper occupied by the printed matter on one side may coincide

exactly with that occupied by the printed matter on the other side.

The type form fixed on the central drum moves at the rate of 70 inches per second, and the paper is moved in contact with it of course at exactly the same rate. Now, if by any error in the delivery or motion of a sheet of paper, it arrive at the printing cylinder 1-70th part of a second too soon or too late, the relative position of the columns will vary by 1-70th part of 70 inches — that is to say, by one inch. In that case the edge of the printed matter on one side would be an inch nearer to the edge of the paper than on the other side.

This is an incident which rarely happens, but when it does, a sheet, of course, is spoilt. In fact, the waste from that cause is considerably less in the present vertical machine than in the former less powerful horizontal one.

The vertical position of the inking rollers is more conducive to the goodness of the work,—for the type and engraving are only touched on their extreme surface,—than the horizontal machine, where the inking rollers act by gravity; also any dust shaken out of the paper, which formerly was deposited upon the inking rollers, now falls upon the floor.

With this machine 50,000 impressions have been taken without stopping to brush the form or table.

The machines at *The Times* are, from their size and the quantity of apparatus, necessarily very costly; but Mr. Applegath has recently patented an improved cylindric machine, to be used either with ordinary or taper-sided type, which has reduced the machine to its simplest form, combining the utmost economy with great speed.

This improved machine, which at the time we write (April, 1852), has not yet been announced to the trade and the public, is adapted to rolls as well as to sheets of paper. It

works without noise, with little power, and requires little or no repair. It is capable of printing on both sides of the sheet, or on one only.

The principle of the vertical cylinder machine (*fig.* 2.) of *The Times*, is capable of almost unlimited extension. Mr. Applegath offered the Royal Commission to make a machine for the Great Exhibition, which with no rate of motion more rapid than that of *The Times*, should print 40,000 sheets per hour, or above eleven sheets between two ticks of a common clock!

The rapidity with which the circulation of newspapers has augmented in this country during the last century, but more especially during the latter half of it, may be judged from the following facts.

In the annexed table is given the total number of newspapers circulated in this country during the years expressed in the first column: —

Years.	Number circulated.	Average Annual Increase.
1751	7,412,575	
1801	16,085,085	173,446
1821	24,862,186	438,855
1831	35,198,160	1,033,597
1841	59,936,897	2,473,873
1849	78,792,934	2,357,005

Thus it appears, that while the average annual increase of the circulation of journals, in the latter half of the last century, was limited to 173,000, the average increase during the past twenty years of the present century was 439,000; the next ten years this rate of increase was more than doubled, and in the succeeding period it was augumented in a sixfold ratio. The total circulation in 1849 was more than ten times the circulation in 1751.

By comparing the circulation of journals with the popula-

tion, an estimate may be obtained, if not of the diffusion of knowledge in general, at least of that description of information of which journalism is the vehicle. In the following table are given the amount of the population at the epochs above mentioned, and the number of journals circulated per head of the population.

Years.	Population.	Number of Journals per Head.
1751	6,377,574	1·1
1801	10,942,646	1·5
1821	14,391,631	1·7
1831	16,539,318	2·1
1841	18,720,394	3·2

Thus, relatively to the population, the circulation of journals had increased in a twofold proportion in 1841, as compared with 1821, and in a threefold ratio as compared with 1751. Taking the population of Great Britain in round numbers, in 1849, at twenty millions, the ratio of journals to the population would be 4 to 1, being an increase in the same ratio on the circulation in 1751.

So far, therefore, as the circulation of journals can be regarded as an exponent of the diffusion of knowledge, a greater amount of general information prevails now than prevailed a century ago in a fourfold proportion.

X.

CALICO PRINTING MACHINES.

No department of the Exhibition was so replete with miracles of art as that appropriated to the machinery employed in the manufacture of cotton, and more particularly in calico printing; and there was none in which the visitor stood more in need of clear explanation, not only of the structure and operation of the machines themselves, but of some of the principal steps by which they have attained their present surprising perfection.

Figured patterns were formerly printed on white cotton cloth by means of wooden blocks cut after a fashion similar to those used at present for wood engravings. These blocks being smeared with a colouring matter, were pressed upon the cotton cloth by hand; and when patterns of more than one colour were produced, different blocks, carrying the figures corresponding with the different colours, were successively applied to the same cloth.

It is evident that a process in which the hand labour bore so large a proportion to the quantity of printed cloth produced could never be the means of fabricating a cheap article or establishing a large manufacture. Invention was therefore stimulated, and the system of calico printing machines by means of engraved copper rollers, of which numerous

specimens were seen in the Exhibition, was, through a series of progressive improvements, brought to its present state of perfection. One machine was exhibited constructed upon this principle by which calico can be printed in eight colours at once; and another which claims a still greater power in reference to the combination and variety of colours. Although such machines in their details are extremely complicated, and would not admit of being rendered perfectly intelligible without the aid of various diagrams, even though the actual machine were under our eyes, the general principle which characterises them may be explained without much difficulty.

The patterns on printed calicoes and similar figured cloths consist, as will be apparent upon the slightest examination, of a continual repetition of the same figure. This figure, whatever it be, so far as it consists of a single colour, is engraved upon a copper roller, the length of which corresponds with the breadth of the calico, and the circumference of which corresponds with the length of the pattern. In general, in such cases, the breadth of the pattern being very much less than that of the cloth, it is repeated many times in the width. This pattern is therefore engraved upon the surface of the roller, the length extending completely round it, and being repeated throughout the length of the roller in the same manner as it is intended to appear on the cloth. This roller receives the colouring matter by a certain apparatus which first smears, and then wipes it, so as to remove all dye except what fills the incisions of the engraving. The cloth is then passed between this roller and another which has a soft surface, the two being pressed severely together in their line of contact. By this process the colour deposited in the lines of the engraved roller is transferred to the cloth, and the printing is completed. When patterns in two colours are to be printed, a second engraved roller is provided, carrying upon it

the pattern corresponding to the second colour, and the cloth, after having been printed with the first colour, is made to pass in contact with this second roller, so that the pattern of the second colour is transferred to the cloth from the roller in the same manner as that of the first, and the movement of the cloth is so nicely regulated that the pattern of the second colour falls into its place, with reference to that of the first colour, with the greatest imaginable precision. Where patterns of three colours are to be printed, a third roller is in like manner provided and worked.

Until lately calico has not been printed by these means in more than four colours; a fifth colour, however, has for some time been added, but by a different, slower, and more expensive expedient. In the machine, however, sent to the Exhibition by Messrs. Mather, of Salford, means of printing in eight colours by a single operation, and afterwards drying the cloth, are provided.

But the most admirable part of this truly admirable machinery, is the method by which the copper rollers on which the patterns are delineated are engraved. It must be evident that for an elaborate pattern the engraving of such surfaces by the operation of ordinary tool engraving would become so costly a process as greatly to enhance the price of the fabricated article; and this would be more especially the case when it is considered how rapidly these engraved copper rollers must be worn by the operation of printing.

To print a piece of calico five quarters in width would require a roller of corresponding length (that is to say), of 45 inches long. Now, if the circumference of such a roller were eight inches, its entire surface would measure 360 square inches, all of which would have to be covered with tool engraving, more or less complicated according to the pattern; and as many such rollers are necessary for the printing of

each piece as there are different colours in the pattern. The enormous expense of producing such rollers has been evaded by an invention which, perhaps, for ingenuity and beauty, is scarcely exceeded by anything in the history of our manufactures.

The following explanation will, it is hoped, render intelligible the mode of producing those engraved rollers at a trifling expense:—

Let us suppose that the length of the pattern, and consequently the circumference of the roller on which it is to be engraved, is limited to six inches. This length, however, is immaterial so far as the principle is concerned. A small roller then of soft steel, is taken, whose circumference is six inches, and whose length is equal to the width of the pattern. Upon the surface of this roller the proposed pattern is engraved by the ordinary process of engraving. This steel roller, with its surface thus engraved, is then hardened by a certain process: it is next placed in contact with another roller of soft steel, against which it is urged by the action of a powerful press, and the one roller being rolled upon the other the surface of the soft roller takes *in relief* an exact impression of the *intaglio* pattern which was previously engraved upon the original roller. This second roller, thus having upon it the pattern in relief, is then hardened, and is rolled upon the copper cylinder to be engraved, urged against it in like manner by the action of a powerful press, and leaves upon it the engraved characters. These rollers being repeatedly applied to the copper cylinder throughout its entire length, the engraved pattern is reproduced in the same manner as it is intended to be printed upon the cloth.

The original steel roller upon which the pattern is engraved is called the DIE, and that upon which the pattern is produced in relief is called the MILL.

It is evident that when a pattern has been once engraved, and a single DIE produced, the number of DIES, MILLS, and ROLLERS bearing the same pattern may be indefinitely multiplied without the expense of further tool engraving, for each DIE can produce an indefinite number of MILLS, and each MILL an indefinite number of DIES as well as an indefinite number of ROLLERS. A roller of soft steel rolled with pressure against a MILL becomes when hardened a DIE.

A pattern, therefore, however complicated, elaborate, and costly, being once engraved, may thus be literally perpetuated, and the expense, however great, attending the first artistic labour applied to the original roller, being spread over the unlimited multitude of rollers which may be made from it, will ultimately vanish, and its influence upon each manufactured article will be insignificant.

When the copper engraved rollers become so worn by use that the patterns lose their sharpness, their surfaces have only to be smoothed and the engraving can be renewed upon them at a nominal expense.

When patterns go out of fashion in England, the cylinders are exported to various parts of Europe and America, or the patterns thus become obsolete may be removed from the surface of the cylinder by the operation of the lathe, and a novel pattern may be imparted to it by similar processes.

It would be difficult to find, in the history of the useful arts, more instructive lessons in commercial policy, than those which may be derived from the progress of calico printing. It was about the year 1676, that calico printing was first introduced in England by a Frenchman, who erected print-works on the banks of the Thames, near Richmond.

No sooner was this enterprise in operation and its productive powers and commercial advantages rendered manifest, than the Demon of Protection was aroused, and a system of

legislative persecution was commenced against it, under which, in half a century, it sunk. In this case the object of the legislature was the protection of the silk and woollen manufactures. The infant calico printing manufacture was in fine strangled and ceased to exist in 1720. The means by which this object was attained were such as, with our present habits of thought and action, will scarcely be credited. Not only was the weaver of the article subject to a fine of 5*l.* for each piece, but the vendor was subject to the still heavier penalty of 20*l.*

After an interval of fifteen years, this system of prohibition was so far relaxed, that calicoes were allowed to be woven, provided the threads of the warp were linen! This system prevailed until the improvements of Arkwright imparted an extraordinary stimulus to the cotton manufacture, when the legislature was forced a step further, and allowed the public to wear printed calico goods subject to an excise duty of 3*d.* a yard. This was augmented to 3½*d.* in 1806, which was continued till the system was finally abandoned in 1831, and the entire duty repealed.

The growth of calico printing in England has taken place chiefly during the present century. The exaction of the duty up to 1830, supplied the means of ascertaining with accuracy the rate at which the manufacture augmented. The following statement shows the quantities produced in the years indicated in the first column: —

Year.	Yards printed.
1796	20,621,797
1800	32,869,729
1814	124,613,472
1830	347,450,299

Thus it appears that the quantity fabricated in 1830,

amounted to more than ten times the quantity fabricated in 1800.

Of the total quantity fabricated in 1830, 55 per cent was exported.

Although the abolition of the excise deprives us of a direct means of ascertaining the exact progress of the manufacture since 1831, we may obtain an approximate estimate from the quantities exported, and the estimated ratio of the exports to the total quantities fabricated. It has been stated that the exports in 1830, amounted to 55 per cent of the total quantity fabricated. Let us assume the same proportion as being still maintained, and calculate from the amounts exported the amounts produced. We shall have then: —

Year.	Quantity exported.	Minor Limit of Quantity fabricated.
1841	329,240,892	598,619,786
1849	542,423,591	986,224,710

Thus it appears that in fifty years, the quantity of calico printed has augmented from 20 millions to 1000 millions of yards, being a fiftyfold increase.

This vast increase must be ascribed mainly to the improved machinery by means of which mere hand labour has been superseded, and no part of the machinery has more contributed to this than the adaptation of engraved rollers above described.

A single calico printing machine, worked by engraved rollers, as above described, and attended by a man to superintend them, and a boy to feed the colour troughs, is capable of producing as much calico per hour, printed in four colours, as would require the labour of 200 men to produce by the old method of block printing. And the economy of labour is, of course, still more surprising, when a machine for printing in a greater number of colours is used.

One of the more recent improvements which merits notice here is the method of giving to cotton stuffs the brilliant red dye of the cochineal, which was previously imparted only to woollens. The expedient by which this has been accomplished, is the very simple one of exposing the cloth which has received the dye for a certain time to a current of steam, which has the effect of fixing the colour.

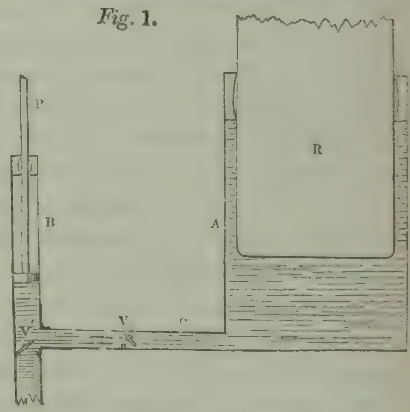
XI.

HYDRAULIC MACHINERY OF THE BRITANNIA BRIDGE.

THE colossal hydraulic press by which that memorable engineering *tour de force* of raising the tubes of the Britannia Bridge from the level of the water to their permanent position on the piers—a height at one place amounting to 120 feet—was placed in the Crystal Palace, where, as a monument of unparalleled enterprise and skill, it attracted universal attention and admiration.

To render the principle of this wondrous engine intelligible, let us imagine two strong cylinders of cast-iron, the outline of the vertical section of which may be conceived by reference to the figure, one A, of large, and the other B, of small capacity, having a pipe of communication C between them, in which a valve V is placed, opening from the small towards the large cylinder. At the top of each of these cylinders is a water-tight collar, in which is inserted a cylindrical rod, turned exactly to fit the

Fig. 1.



collar, and which, moving in the collar so as to be water-tight, descends into the cylinder. These rods are each a little less in diameter and in length than the cylinders, so that when they have descended in them a space will remain around and below them. The larger, R, of these rods, which moves in the great cylinder, is called the "ram," and the smaller, P, which moves in the lesser cylinder, is called the "plunger."

Let us suppose that the ram R is let down in the great cylinder, and the plunger P raised to the top of the small cylinder, and let the two cylinders and the communicating pipe be imagined to be completely filled with water.

If the plunger be then pressed down in the small cylinder, it will drive so much water as it displaces from that cylinder through the communicating pipe and valve V into the large cylinder, where the ram will be compelled to rise to give space for it. The height through which the ram will be thus raised, will depend on the proportion which its magnitude bears to that of the plunger. Thus, if the bulk of an inch of the ram be 500 times greater than the bulk of an inch of the plunger, it is evident that the 500th part of an inch of the ram will occupy a space equal to, and will displace as much water as would an inch of the plunger. To raise the ram, therefore, in such case, through the height of 1 foot, the plunger should be moved through 500 feet.

Each time that the plunger is raised to repeat the stroke, water is drawn into the lesser cylinder so as to refill it from a reservoir, through the suction valve v, on the principle of the common pump, and during this process the water which had been driven into the large cylinder cannot return, being stopped by the valve V, in the communicating pipe, which opens towards the large cylinder.

To estimate the force with which the ram will be pressed upwards by the water driven under it, we must consider that

the pressure produced on each square inch of the section of the plunger will produce an equal pressure on each square inch of the section of the ram. This is an immediate consequence of the fluidity of the water which is interposed between the plunger and the ram. If, then, as we have supposed, the section of the ram be 500 times greater than the section of the plunger, it will follow that a pressure of one ton exerted by the plunger will produce an equal pressure of 500 tons upon the ram.

Such is the general principle, and such the essential parts of the hydraulic press, of which so stupendous a specimen was presented to the visitor in the machine which raised the Britannia tubular bridge.

The weight and bulk of this cyclopean engine are in accordance with its vast mechanical power. The great cylinder is 9 feet long, 22 inches internal diameter, 10 inches thick, and weighs 15 tons! It is a mass of cast-iron. Allowing for waste, and for the head or "git," 22 tons of fluid incandescent iron were required for this enormous casting. After being left for seventy-two hours in the mould in which it was cast, the mould was detached from it. *It was still red hot!* It was then left to cool, and it was *ten days* before it was sufficiently cool to be approached by operatives well inured to heat for the purpose of detaching from it the part of the sand of the mould which still adhered to it.

The ram, which is the immediate object that receives and transmits the pressure, is also cast-iron, measuring 20 inches diameter, and weighing 3 tons, 13 cwt.

When the weight and bulk of these working parts of the engine, and the vast force exerted by them are considered, it will be easily understood that corresponding strength must be provided in the framing and moulding of it.

The form, arrangement, and operation of this vast piece of

hydraulic machinery will be more clearly understood by referring from our description of its several parts, to the annexed diagrams, which have been reduced from those given in the Official Catalogue.

A front view of the machine is represented in *fig.* 2., a side view in *fig.* 3., and the manner in which it was applied to elevate the tubes is shown in *fig.* 4. The same letters indicate the same parts in these diagrams.

The cylinder D is enclosed in a cast-iron jacket C, bound round by wrought-iron slabs, which being placed around it when red hot, were allowed to cool, and in cooling contracted so as to grasp the casting with irresistible force. The weight of this compound jacket of cast and wrought iron is eight tons.

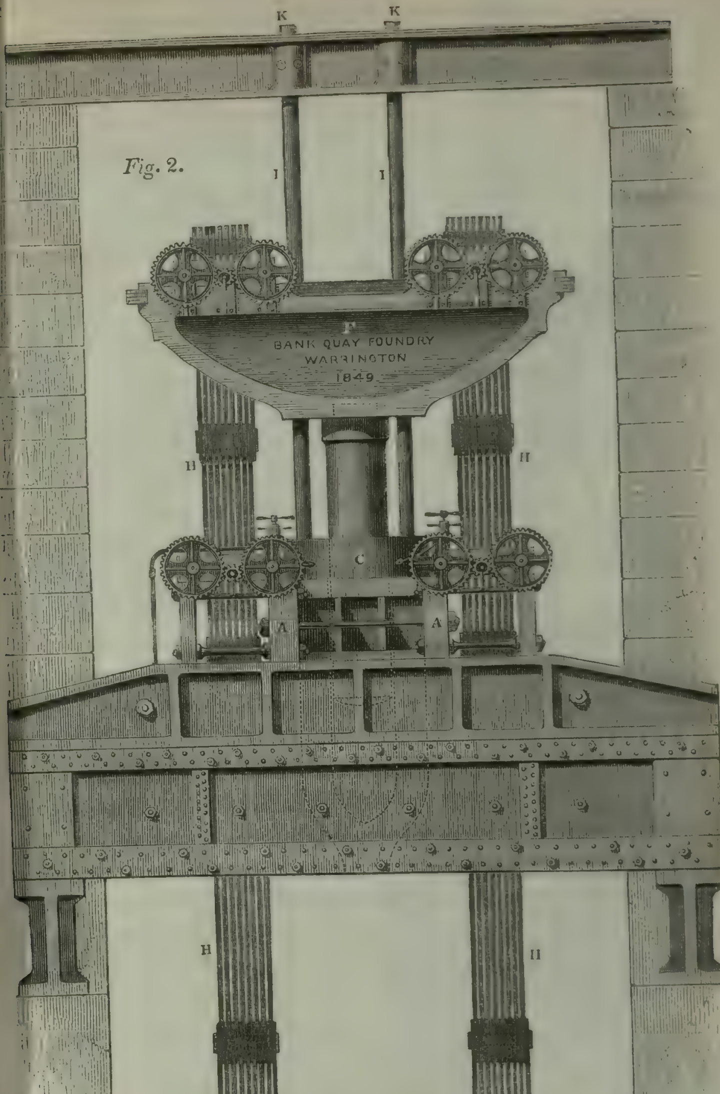
The cylinder and ram thus enclosed in the jacket rest upon horizontal beams B, of cast-iron, each of which weighs five tons. These beams themselves rest upon compound girders A, of curious construction, which form the basis and bear the entire incumbent weight of this immense piece of machinery.

These girders are composed of plates of wrought-iron 5-16ths of an inch thick, alternated with boards of American elm $2\frac{1}{8}$th inch thick, the timber and the iron being united after the fashion of a *sandwich*, and the entire girder being composed of six plates of iron alternated with six interposed boards of elm. This compound beam of wood and iron, the plates and boards being placed with their planes vertical, their edges being presented upwards and downwards, is secured at top and bottom by twelve wrought-iron bars extending the whole length of the beam.

The weight of each of these *sandwiches* is twelve tons!

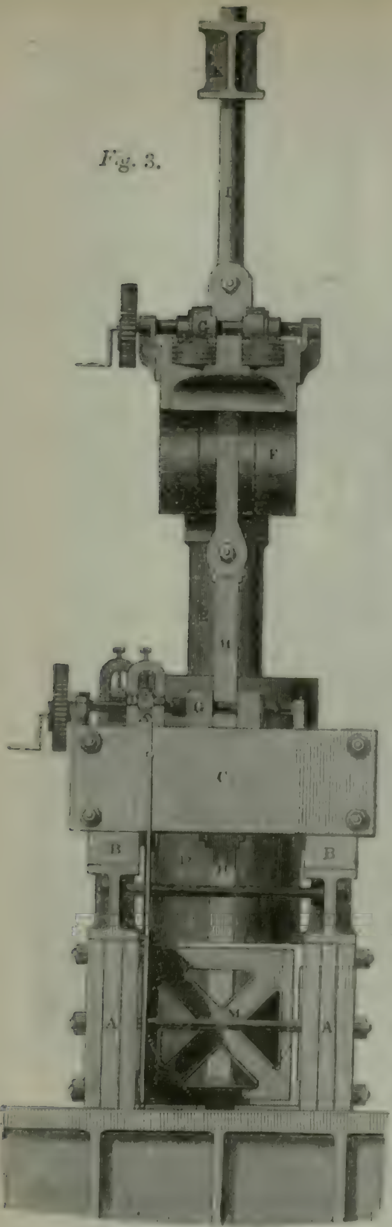
But let us see the means whereby the ram is made to elevate the bridge.

To the top of the ram is attached a cross-head, F, of cast-iron. The ram, being, as we have stated, a cylindrical rod



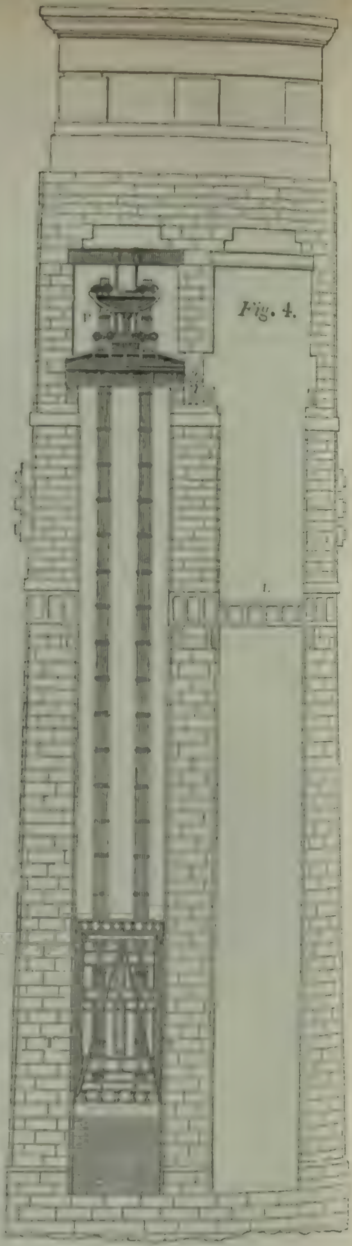
ELEVATION OF HYDRAULIC PRESS.

Fig. 3.



SIDE VIEW OF HYDRAULIC PRESS.

Fig. 4.



ELEVATION OF TOWERS OF BRITANNIA BRIDGE.

20 inches in diameter, is let into a hole of corresponding size made in this cross-head, on which it is securely fastened. The weight of this cross-head is 13 tons.

To prevent the ram from suffering any lateral strain during its action, the cross-head is made to work on vertical guide rods I, of wrought-iron, each 6 inches in diameter, which are fixed in sockets K, on the top of the press. To the cross-head were attached the chains H, which descended to the level of the water and embraced the tube to be raised.

The greatest weight lifted by the press was 1144 tons, but it was capable of raising 2000 tons. The quantity of water injected into the great cylinder, in order to raise the ram 6 feet, was $81\frac{1}{2}$ gallons. When a lift of 6 feet was effected, the lifting chains were seized by a set of clamps under the lowest point to which the cross-head descended, and while they were thus held suspended the water was discharged from the great cylinder, and the ram, with its cross-head, made to descend. Meanwhile, the lengths of the chains above the clamps were removed, and the chains thus shortened attached to the cross-heads by other clamps connected with the cross-head, and all was prepared for another lift.

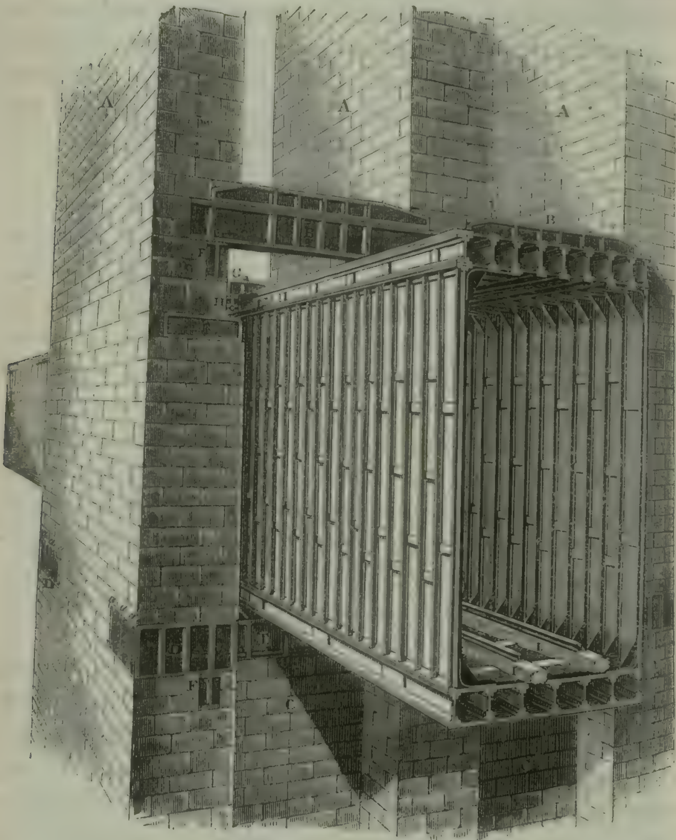
In the practical operation of the machine, each lift of 6 feet occupied from thirty to forty-five minutes.

The manner in which the tubes were elevated is indicated in *fig.* 4. The square section of the tube is represented at T, filling a space between two piers of masonry. The chains attached to it are continued upwards to the press P. When, by the operation of the press, the tube was lifted through a height of 6 feet, the vacant space under it was built up. The same process was repeated after each lift, until at length the tube was raised to the intended level L, of the roadway.

To facilitate still more the conception of this stupendous

mechanical operation, we give, in *fig.* 5., a perspective view of a portion of the tubes resting upon the centre tower, in the

Fig. 5.



VIEW OF TUBULAR BRIDGE.

middle of the Strait. The original from which this has been reduced, may be seen in Mr. Fairbairn's work on the Conway and Britannia Tubular Bridges.

No error is more widely disseminated, or more difficult to be eradicated from the minds of those who seek for a smattering of mechanical science without submitting to the discipline of elementary instruction, than the supposition that by means of machinery a small amount of mechanical force is capable of producing an indefinitely great mechanical effect; and among the infinitely various machines which were exhibited in the Crystal Palace, there was not one which so largely contributed to this error as that which we have explained above, — so much so, that the effects it exhibits have, even among rigorously exact writers on mechanics, acquired the name of the "hydrostatic paradox." The principles of mechanics and their practical application, however, when rightly understood, involve no paradox, but are, on the contrary, in accordance with the most ordinary and popular notions of the phenomena of force and motion.

A small power working through a large space, raising a great weight through a small space, is merely an expedient by which a feeble power is enabled to accomplish its task, by a long succession of efforts, without dividing the weight. To raise the weight of a ton by a single effort one foot, would require a force equivalent to the weight of a ton. But if, by the intervention of a machine, a power is enabled to accomplish this object by 2240 distinct efforts, each effort working through one foot, then such power need not be more than one pound; or 2240 efforts made through the space of one foot, each effort exerting the force of one pound, will be mechanically equivalent to 2240 lbs., or one ton raised through one foot, and the effect produced will be the same as if the weight were actually divided into 2240 equal parts, and the power applied successively to raise each of these parts one foot.

To apply this to the case before us, let us suppose that the section of the ram R, *fig.* 1., is 1000 times greater than

that of the plunger or piston P. According to what has been already stated, a pressure of 1 lb. acting on P, will produce an upward pressure of 1000 lbs. on R, so that a weight of 1 lb. acting on P, will support 1000 lbs. resting on R. Now if the piston P be moved downwards with a force of 1 lb., the ram R would be raised with a force sufficient to lift 1000 lbs.

There is, nevertheless, in these facts, nothing contrary to what might be inferred from the common principles of mechanics. The action of the forces here supposed, differs in nothing from that of like forces acting on a lever having unequal arms in the proportion of 1 to 1000. A weight of 1 lb. acting on the longer arm of such lever, would support or raise a weight of 1000 lbs. acting on the shorter arm. The liquid, in the present case, performs the office of the ever, and the inner surface of the vessel containing it performs the office of the fulcrum.

Nor is there in the fact that 1000 lbs. on the ram R are raised by the descending force of 1 lb. on the piston P, anything which might not be naturally expected. If the piston P descend one inch, a quantity of water which ocupies one inch of the cylinder B, will be expelled from it, and as the cylinder A is filled in every part, the ram R must be forced upwards until space is obtained for the water which has been expelled from the cylinder B. But as the sectional area of the cylinder A is 1000 times greater than that of the cylinder B, the height which the ram R must be raised to give this space will be 1000 times less than that through which the piston P has descended; therefore, while the weight of 1 lb. on P has been moved through one inch, the weight of 1000 lbs. on R will be raised through only the $\frac{1}{1000}$th part of an inch. If this process were repeated a thousand times, the weight of 1000 lbs. on R would be raised through one inch; but

in accomplishing this, the weight of 1 lb. acting on P, would be moved successively through 1000 inches. The mechanical action, therefore, of the power in this case is expressed by the force of 1 lb. acting successively through 1000 inches, while the mechanical effect produced upon the resistance is expressed by 1000 lbs. raised through one inch.

Now, it is evident that in this there is nothing really paradoxdical or difficult.

If the power could act directly on the 1000 lbs. which rest upon the ram R, and could separately raise them pound by pound one inch, it would accomplish the same mechanical effect without the instrumentality of the hydrostatic apparatus here described.*

Another hydraulic press of stupendous magnitude is erected at the works of Messrs. Hicks and Son, of Bolton. This machine, of which a model only and some specimens of its wondrous power were presented in the Exhibition, consists of four great cylinders, the rams of which are enabled to direct their united power on the same point, and are all driven by the same force pump. Each of the four great cylinders weighs two tons, and when combined they are capable of producing an aggregate pressure upon any object submitted to their action of 2500 tons.

The advantages claimed for this species of compound press over a single cylinder of greater magnitude which would have the same power are, that the four cylinders may be worked together or independently, and that much better castings are obtained in consequence of their diminished weight; a single cylinder of equivalent power would weigh 20 tons, whereas the aggregate weight of these four is only 16 tons.

* For a full development of these principles, see Lardner's Handbook of Natural Philosophy, pp. 193. 305.

Planks of cold iron of different thicknesses have been punched by the large press, and it has been found that for the thickness of $1\frac{1}{2}$ inch a pressure of 700 tons has been necessary; for 2 inches thickness the pressure required was 950 tons; for $2\frac{1}{2}$ inches thickness, 1250 tons; for 3 inches thickness, 1600 tons; and for $3\frac{1}{2}$ inches thickness, 2050 tons. A hole eight inches in diameter was punched through a plank of cold wrought iron four inches thick by this machine with as much apparent facility as though the substance thus pierced were as soft as cheese.

Specimens of these astonishing effects were shown in the Exhibition.

XII.

WHITWORTH'S MICROMETRIC APPARATUS AND MANCHESTER TOOLS.

In the department of machinery, a collection of turning, planing, boring, and cutting machines, on a scale of extraordinary magnitude, was exhibited by Messrs. Whitworth; and near them an instrument on a smaller scale, which attracted much notice on the part of the scientific men who have visited the Exhibition, by which magnitudes so minute as even to elude the microscope, have been submitted to mechanical measurement.

This admirable instrument, for which, as well as for the other machines exhibited by Mr. Whitworth, a council medal has been granted, is not a mere object of scientific curiosity, but has been applied to purposes of the greatest practical utility, by affording means for the establishing uniform standards of magnitude for taps, axles, and other important component parts of machinery, among which it is as necessary to maintain uniformity as it is to have a uniform language or a uniform system of numeration. By the instrument to which we now refer, magnitudes are actually estimated which do not exceed the one-millionth part of an inch.

Two perfectly plane and smooth metallic surfaces are first

formed, partly by friction against each other, and partly by abrasion with a peculiar tool.

So plane are the surfaces of metal thus formed, that when one is laid upon the other no one part comes into closer contact than another, and there is included between them a stratum of particles of air which act like infinitely smooth rollers, and the surfaces move in contact one with another with a degree of freedom, owing to the lubricity of the air, which must be felt to be conceived. If, however, the surfaces be so severely pressed against each other as to exclude the air, the contact becomes so complete that it is with great difficulty they can be separated.

These surfaces, thus accurately formed, are used as standards to test other plane surfaces, and with these are tested the ends of a standard measure of metal, which is placed in an accurately formed horizontal metallic bed. One end bears against a metallic pin; another metallic pin, urged by a screw, presses against the other end; and if this metallic bar, by change of temperature or any other cause, suffer a change in its length amounting to the millionth part of an inch, that change is rendered perceptible by the following arrangement: —

The pin which bears against its extremity is moved by a screw, which has 10 threads to the inch. On the head of this screw is a wheel, consisting of 400 teeth, which works in a worm driven by another wheel, the rim of which is divided into 250 visible parts. Now, since each thread of the original screw corresponds to the 1-10th part of an inch, each tooth of the wheel upon its head will correspond to the 4000th part of an inch, and each division of the wheel attached to the worm will correspond to the millionth part of an inch.

It is found, in the application of this apparatus, that a

change in the position of the wheel attached to the worm, through one of the 250 divisions, is rendered sensible at the point of the screw which bears against the standard bar; but since the motion of the former wheel through one division can produce a motion amounting only to the millionth part of an inch in the point of the screw, this magnitude is thus rendered sensible.

To prove the accuracy of this micrometric apparatus, a standard yard measure made of a bar of steel, about three quarters of an inch square, having both the ends rendered perfectly true, was placed in it. One end of the bar was then placed in contact with the face of the machine, and at the other end, between it and the other face of the machine, was interposed a small flat piece of steel, termed by the experimenter "the contact piece," whose sides were also rendered perfectly true and parallel. Each division on the micrometer represented the one-millionth part of an inch, and each time the micrometer was moved only one division forward, the experimenter raised the contact piece, allowing it to descend across the end of the bar by its own gravity only. This was repeated until the closer approximation of the surfaces prevented the contact piece from descending, when the measure was completed, and the number on the micrometer represented the dead length of the standard bar to the one-millionth part of an inch.

Eight repetitions of the experiment in a quarter of an hour produced identical results, there not being in any case a variation of one-millionth of an inch.

This method of operating was termed "the system of proof by the contact of perfectly true surfaces and gravity;" and in connexion with it was shown another interesting experiment.

When the micrometer was screwed up within one division

of the number where contact would be presumed to occur, the warmth of the finger applied to the centre of the steel bar sufficed to expand and lengthen it instantaneously, so as to prevent the descent of the "contact piece."

The other method of proof was by having a small simple battery composed of a piece of zinc soldered on to a piece of copper and plunged into rain water, without the admixture of any acid; this was connected with the two ends of the measuring machine, and also with a delicate galvanometer. On pursuing the same process of advancing the micrometer one division at a time, no effect was produced until the last millionth of an inch of distance was traversed, and absolute contact occurred with the end of the bar, when the deflection of the needle of the galvanometer instantly betrayed the movement. Repeated experiments showed this to be unerring in the result, and on placing the finger on the middle of the bar, under the same circumstances as in the other course of experiments, the expansion was instantly detected by the deflection of the galvanometric bar.

By the application of this instrument, standard gauges for axles, taps, and other parts of machinery which it is desirable to maintain uniform, are constructed, and have been adopted by the Admiralty.

One of the large machines exhibited by Messrs. Whitworth was a lathe capable of turning shafts 36 feet long. The peculiarity of this machine is the combination of two cutting tools at the opposite sides of the shaft to be turned, which bear against each other, and are governed by a common motion. Another pair of similar cutting tools is also placed on the bed of the same lathe. When a long shaft is to be turned, these four tools are brought to its middle point, and commence from that point cutting in opposite directions towards the extremities of the shaft. The advantage of the

tools bearing on opposite sides is that all flexure of the bar, which may proceed from the pressure of the tool, is prevented by their mutual reaction.

Near this was another lathe of great magnitude, constructed on the same principle, for turning and boring the wheels of railway engines and carriages. The wheels, fixed upon their axle, are suspended between the two face-plates of the lathe, and two pairs of cutting tools are applied to opposite sides of them in the same manner as has already been described.

XIII.

COME AND SEE THE EARTH TURNING ON ITS AXIS!

The public in Paris were startled one day last spring by an invitation which appeared in the newspapers to go to the Pantheon, and *look at the earth turning on its axis!* This novel exhibition of a phenomenon, known hitherto to the great mass of mankind only by hearsay, was produced by the realisation of a happy idea which occurred to M. Leon Foucault, a *savant* who, though still at a period of life at which few emerge from obscurity, has already been known to the scientific world for his successful researches in several branches of experimental physics, and who, at the last election to a vacant seat at the Institute, was the competitor of the Baron Cagniard de la Tour, obtaining nearly an equal number of suffrages.

Notwithstanding the incontestable proofs of the earth's diurnal rotation derived from analogy, and from the consideration of the apparent diurnal motion of the firmament, not only did the great mass of the public long and obstinately refuse its assent to a proposition apparently so monstrous as that the solid ground on which we stand, and which sustains the most stupendous structures natural and artificial, is moving under us at the rate of 6 or 700 feet per second,

but even the most instructed and enlightened resisted the doctrine, and closed the avenues of their mind against all the arguments by which it was sustained. One of the most learned men and boldest thinkers of the last century, the illustrious Feller, for a long time resolutely rejected the doctrine, and would probably have remained for ever sceptical, had not a young Jesuit of his acquaintance, discussing the point with him one day, appealed to him after this fashion:— "But, my good father, it seems to me much more natural that the joint to be roasted should be turned before the fire, than that the fire should be moved round the joint; and if our cooks are too knowing to adopt the latter clumsy method, why should we suppose that the great Architect of the Universe would so far depart from the course indicated by common sense?" Feller had no reply to offer.

To appreciate the reasoning upon which the fact of the earth's rotation is established, it is necessary to remember, that all motions which are perceived by the sense of sight, are known only by their relation to visible objects which *do not participate in them.* It is the relative change of position of the object moved, with respect to other objects not moved, which is perceived, and which is to the observer the indication, and the only indication, of the motion. If all the objects which fall within the view of the observer partake of a common motion, no change in their relative position will be manifested, and the observer will be unconscious of the motion, however real it be. A person placed in the cabin of a boat moving on a river or canal, is conscious of no motion; but if he look out at the window he will see the banks, which he well knows are at rest, appear to move in a direction contrary to the motion of the boat. From this relative change of position of the objects on the banks with respect to the boat, he *infers* the motion of the boat.

When we observe attentively the firmament during a night and day, it is found to have an apparent motion round us: such a motion as would be produced if it had a rotation round a certain line passing through a point in the heavens called the *pole*, as an axis, the rotation being completed once every twenty-four hours. Now, this appearance can be produced only by one or other of two causes; first, by the universe revolving round the earth, or, secondly, by the earth revolving on that diameter of itself which is parallel to the line on which the firmament *appears* to revolve. Either of these causes would indifferently explain the diurnal phenomena. If any proof can be adduced that the earth *does not* revolve, it will follow that the universe *does;* and if, on the other hand, it can be shown that the universe *does not* revolve, it will follow, as an irresistible logical consequence, that the earth *does.*

So repugnant was the mind of man to admit the motion of the earth, that the former supposition of the rotation of the universe was entertained for ages. When, however, the researches of astronomers supplied an estimate of the prodigious distances and magnitudes of the celestial bodies, many of which are more than a million times greater than our globe, the improbability, not to say physical impossibility, of their revolution round the earth once every twenty-four hours, became so glaring, and, on the other hand, the rotation of the earth upon its axis in that interval became so simple, so natural, and so completely in harmony with the other planets — which have a like rotation on their axis in intervals not very different — that it was impossible longer to resist the admission of the earth's motion.

Nevertheless, some more direct and positive evidence of this important fact was still desired. What evidence was possible? Motion, as we have explained, can only be ren-

dered visible provided it take place in the presence of some object which *does not move*, or, at least, which does not participate in that particular motion which is under observation. But, in this case, how is it possible to render visible the earth's rotation, since *all* objects upon the earth participate in it? The problem, therefore, is reduced to find some object, or, if not to be found, *to create* some object upon the earth, which does not participate in the earth's rotation. He who can produce such an object, may confidently invite the public "*to come and see the earth turning on its axis.*" M. Leon Foucault has done this.

Like all inventions and discoveries of an high order, this of M. Foucault is characterised by such simplicity, and is so familiar and so obvious, that, regarding it for the first time, our only wonder is that it was not suggested and applied ages ago.

A heavy ball, suspended by a string, is made to vibrate after the manner of a pendulum. It is demonstrable, upon the most simple and elementary principles of mechanics, and capable of experimental verification by means which are within the reach of all the world, that the *direction of the arc of vibration* of such a pendulum will not be changed, but will remain parallel to itself, while the pendulum is carried round in a circle. Let such a pendulum, properly mounted, be placed upon the edge of a round table, and let it be made to vibrate in an arc which is parallel to one of the walls of the room. Let the frame supporting the pendulum be moved smoothly and uniformly round the table. Observe the direction of the arc of vibration as it moves. You will find that it will not, as might be expected, everywhere keep the same direction in relation to the centre of the table, but that it will keep rigorously parallel to the wall of the room. At two opposite points of the table the arc of vibration will be

in the direction of that radius of the table which passes under the point of suspension of the pendulum. At two other points, also diametrically opposed, and at right angles with these, the arc of vibration will be at right angles with that radius of the table which passes under the point of suspension. In fine, it will be found that, in all positions, the arc of vibration, remaining parallel to the same wall of the room, will necessarily make with that radius of the table which passes under its point of suspension, the same angle which the wall of the room makes with the same radius of the table.

In this case the direction of the arc of vibration is fixed, while the pendulum is carried round the table; and if we were excluded from all other observation of the transport of the pendulum, except that which would result from a comparison of the direction of the arc of vibration with the direction of that radius of the table which passes under the point of suspension, we should, in this comparison, see the motion of the pendulum round the table.

Now let us suppose the table to be that part of the globe of the earth which surrounds the north pole, and which extends to our latitude. It is true the surface of the table will, in this case, be convex and not flat, the pole being at its centre. Let us, however, for the present, neglect its convexity, and consider what would take place if it were flat. A pendulous ball, such as we have described, erected here in London, would be carried round the edge of this great table, of which the pole is the centre, once in twenty-four hours. But the arc of vibration will be directed to the pole only at two points, which, on the supposition we have made, would be diametrically opposite. At all intermediate points, the arc of vibration would make with the line directed to the north, an angle which would vary in magnitude according to

the distance of the pendulum from those points at which the arc would be directed to the north.

In the case we have here supposed, the arc of vibration would appear to revolve round the line directed to the north, completing its revolution in twenty-four hours, and therefore moving through an angle of 15° per hour. In reality, however, the direction of the arc of vibration would be fixed, and the line directed to the pole would move round it in common with the earth.

We have here stated what would happen if the surface of the earth surrounding the pole were flat instead of being convex, as it actually is. How, then, it may be asked, will this convexity modify the effects above described? Without going into a detailed exposition on this point, which the purpose of this notice and our necessary limits exclude, we may state that the consequent modification is only in the *rate* at which the arc of vibration appears to move round the line directed to the north. Instead of making a complete revolution round that line in twenty-four hours, it moves at a slower rate, depending on the distance of the place from the pole, and increasing in a certain determinate proportion as that distance increases. At a given place, however, the *apparent* motion of the arc of vibration round the meridian line, which, as we have explained, is the *real* motion of the meridian line round the arc, is uniform.

The rate of this motion diminishes rapidly as the pendulum approaches the equator, and the direction of the motion is reversed when it is brought into the southern hemisphere.

In mentioning the rotation of the earth, we have described it as being completed in 24 hours. This must be understood as 24 hours of *sidereal time*, which are equal to $23^{h}.\ 56^{m}.\ 4{\cdot}09^{s}$.

When, therefore, we are invited to see the earth moving on its axis, what we *do* see is, the direction of the meridian

or northern point turning round the direction of the arc of vibration of the pendulum; but what we *think we see*, until we are otherwise instructed, is the arc of vibration turning round the direction of the northern point. While, in fine, the table over which the pendulum vibrates, *moves under the pendulum*, the pendulum *appears* to *vibrate in a varying direction* over the table. The force of the demonstration will, therefore, depend on our previous conviction that the direction of the arc of vibration of the pendulum is *relatively fixed*, and that the apparent motion is that which the table really has in common with the earth.

It had been proposed to exhibit this beautiful experiment in the Crystal Palace. Circumstances, however, preventing this, it was exhibited at the Polytechnic, and various other scientific institutions.

* This experiment admits without difficulty of being exhibited in a room. M. Leon Foucault erected it in one of the drawing-rooms in Dr. Lardner's residence in the Faubourg St. Germain, Paris, where it was exhibited on the occasion of a *soirée* given there, on the 28th February, 1852.

XIV.

THE PIANO-FORTE.

THE piano-forte, under whatever aspect it may be considered, must ever be regarded as the first and most important of the instruments of music. It has been most aptly denominated "the orchestra of the drawing-room." Its power of tone and expression, infinitely varied, places within its range every style of musical composition. The solidity and durability of its mechanism, and its resistance to the vicissitudes of temperature and climate, give a prodigious extension to its utility, since it can be transported without injury or difficulty from the places of its fabrication to the most distant parts of the globe. It is ever ready for the hand of the performer, requiring neither the frequent tuning, stringing, and adjustment indispensable with other stringed instruments, nor taxing the lungs and other vital functions like wind instruments. When once correctly tuned, it is not liable, from accidental causes beyond the control of the performer, to change its pitch like the latter class, nor to produce false notes, from any incorrectness of ear in the executant, as in the case of a stringed instrument stopped by the finger. Of all forms of musical instruments, it is that which lends itself with most felicity to the purposes of instruction. So true is this, that it is difficult to conceive the possibility in these days of obtaining any general knowledge of music without more or less acquaintance with the piano-forte. Hence, this instrument has become a most important object in the

business of education. In female education especially, it is an essential element rather than an elegant accomplishment.

From these causes, the manufacture of piano-fortes has become a branch of national industry of considerable importance, whether it be regarded with reference to the scale upon which it is conducted, or the class of labour it employs. We have not been able to obtain any certain or exact statistical data by which a calculation of its magnitude or value can be estimated. In the absence of such precise data, however, some approximation may be made by comparison with the ascertained extent of the same manufacture in a neighbouring country, where it is certainly fifty per cent less in quantity and value than in England.

At the Great Exposition of the Products of French Industry, which was held in Paris in 1849, it was ascertained, by official documents placed at the command of the juries, that the annual value of the pianos fabricated in France, was above eight millions of francs; and, since the manufacture was then and since in rapid development and increase, we shall not probably over-estimate its present amount by stating it at ten millions of francs, or four hundred thousand pounds sterling.

So great a consumption of this manufacture may be explained, partly, by the inevitable effects of time and climate even on the most solid and durable mechanism, partly by the wear and tear proceeding from use and abuse, especially in the extensive class of instruments used for teaching, and partly by the augmented population to whose enjoyment the instrument ministers; but much must also be ascribed to the increased cultivation of music, and to the rapidly progressive improvement of the mechanism of the piano, which presents to the more affluent a constant inducement, nay, a sort of social necessity, to reject the pianos they possess, not because they are impaired by time or use, but because the

genius and invention of the makers have placed before them better and more powerful instruments.

Considering that by far the largest number of instruments constructed are of a small size and low price, we may take the average cost, one with another, at about a thousand francs, which would give the number of piano-fortes annually fabricated in France to be ten thousand, of which about thirty per cent, or three thousand, are exported.

The industry occupied in this business is nearly all of the class of skilled and artistic labour, and is consequently highly remunerated. In the report of the jury on the French Exposition, the average wages was estimated at five francs per day. The number of pairs of hands occupied in the manufacture may therefore be estimated at nearly seven thousand.

If, in the absence of better and more exact means of calculation, it be assumed that the manufacture in England is double this in quantity and value, we may infer that in the United Kingdom the fabrication of pianos produces a gross return of 800,000*l.*; that about 20,000 instruments are fabricated annually; and that about 14,000 pairs of skilled hands are occupied in the business.

This approximate estimate, considerable in amount as it will appear, is below that which has been made by others who have investigated the statistics of this branch of industry. The following appeared in one of the reviews of the Great Exhibition, which appeared in the journals : —

Estimate of Piano-fortes annually made in London.

1,500	grands, bichords, and small grands, at	£110 each =	£165,000
1,500	squares - - -	60	90,000
20,000	uprights of various kinds -	35	700,000
23,000			£955,000

According to this approximate estimate, the produce of

the London manufacture alone, not including that of the cities of Edinburgh and Dublin, besides towns of less magnitude, amounts to a million sterling. If this estimate be correct, the extent of this branch of industry, in England, is about three times its amount in France.

We received from Messrs. Broadwood, on the occasion of the Great Exhibition, some documents, showing in detail the various classes of operatives, and the different qualities and sorts of materials used in the manufacture of piano-fortes. Our limits rendered it, at the time, impossible for us to avail ourselves of this interesting body of industrial statistics, and it has since been made public in other journals. We avail ourselves of this occasion to reproduce it.

In the fabrication of pianos, there are above forty different classes of operatives employed, each of whom, with his assistants, is exclusively engaged in a special branch of the manufacture. They are as follows: —

1. The *key-maker* forms the entire key-board from one piece of lime-tree wood; fixes on the pieces of ivory and ebony; bores the necessary holes; and, finally, cuts the whole up into separate keys with a fine saw.

2, 3, 4, 5. The *hammer-maker*,— the *check-maker*,—the *damper-maker*, and the *damper-lifter-maker*, construct the parts of the action to which these names refer.

6. The *notch-maker* covers, with doeskin and cloth, the notches or ends of the hammer-shanks into which the hoppers work.

7. The *hammer-leatherer* covers the hammer-heads with their different coats of leather and felt, and cuts them to their proper size.

8. The *beam-maker* makes the mahogany beam or rail, extending across the action, and covered with brass, in which the hammers are centered.

9, 10, 11. The *brass stud-maker* and *brass bridge-maker* form the upward bearing-studs and bridge; and the *wrest pin-maker* makes the iron tuning-pins.

12, 13, 14, 15. The *metallic brace-maker*, — the *metallic plate-maker*, — the *steel arch-maker*,—and the *transverse bar-maker* all construct parts of the metallic bracing.*

16. The *spun string-maker* makes the lapped or spun wires.

These parts, and other minor preparations, being supposed ready, the body of the instrument is made as follows : —

17, 18. The *sawyer* saws the timber roughly into shape; the *bent side-maker* then cuts it more accurately to its size and thickness, and bends, by a steaming process, the pieces destined to form the curved side of the instrument.

19, 20. The *case-maker* fashions, puts together, and veneers the timber framing forming the principal body of the instrument; he also forms and fixes the wrest-plank. The *bracer* inserts the timber cross-bracing in the frame; this is, however, sometimes done by the case-maker.

21. The *bottom-maker* makes and fixes the framed bed, at the lower part of the instrument, to receive the key-board.

22, 23. The *sounding-board-maker* selects the timber for, cuts out, and joints, the sound-board. The *belly-man* planes it to its proper thickness, shapes it, finishes it, and fixes it in the case. He also forms and fixes upon it the beech bridge, upon which the strings take their bearing.

24. The *marker-off* has more to do than his name implies. He marks out the scale for the strings, fixes the pins in the beech bridge, and finishes it to its proper shape; he inserts the upward bearing-bridge and studs in the wrest-plank, and bores it ready to receive the tuning-pins; he also fits and fixes the metallic string-plate, longitudinal stretcher-bars, and other parts of the metallic bracing, by which the piano-forte is made ready to receive the strings.

25. The *stringer* puts on the strings, and fixes the wrest-pins in their places.

26. The *finisher* receives the keys and the various parts of the

* The makers of the iron and brass work, for piano-fortes and other musical instruments, are called *music smiths*.

action from their respective makers; he constructs the action-framing, puts the action together, fixes it in its place, and brings the whole of the mechanism generally into playing order.

27, 28. The *rougher-up* then tunes the instrument for the first time, stretching the strings to their proper tension; after which the *tuner* puts it thoroughly and permanently in tune.

29, 30. The *regulator of action* then examines and carefully adjusts every part of the action, and completes the regulation of the touch; and, finally, the *regulator of tones* examines the tones and corrects all irregularities, making the piano-forte sound perfect throughout.

The following operations, which have reference to the external part of the instrument, are done at various times in the course of its construction: —

31, 32. The *top-maker* constructs and veneers the cover, and puts on the hinges. The *plinther* fixes and veneers the plinth.

33. The *fronter* shapes, hinges, and centres the fall or cylinder front; shapes the cheeks, makes and fixes the mouldings, puts on the locks, and attaches the ornaments.

34. The *canvas frame-maker* makes an open wood framework, covered with canvas, which is fixed in the bottom of the instrument.

35. The *lyre-maker* makes the lyre-shaped bracket, fixed under the instrument to carry the pedals.

36, 37. The *leg block-maker* makes and fixes the blocks into which the legs are screwed; and the *leg-maker* makes the legs themselves.

38, 39, 40. The *turner*, the *carver*, and the *gilder*, do all work wanted in their respective departments.

41, 42. The *scraper* scrapes and cleans the surface of the case, and prepares it, by rubbing it with glass paper, for the *polisher*, who gives it its coat of French polish.

It is almost superfluous to add, that all the hands employed

in the manufacture must be well skilled in their respective departments; and that the whole of the operations (but most particularly those connected with the framing and action) must be done with the utmost care, or a good result cannot follow. It is moreover found necessary, in order to ensure the good quality of the instrument, that the work be not hurried, but that it should progress slowly and gradually to completion. A grand piano-forte usually remains in hand upwards of six months.

The following table gives a list of the different materials required in the construction of a piano-forte, specifying the parts of the instrument where they are used: —

MATERIAL.			WHERE USED.
	Woods.		
Oak..........	from	Riga.............	Framing, various parts.
Deal.........	,,	Norway.........	Wood bracings, &c.
Fir...........	,,	Switzerland.....	Sounding-board.
Pine.........	,,	America.........	Parts of framing,—key-bed, or bottom.
Mahogany..	,,	Honduras.......	Solid wood of top, and various parts of the framing and the action.
Beech.......	,,	England.........	Wrest-plank, bridge on sound-board, centre of legs.
Beef wood..	,,	Brazils...........	Tongues in the beam, forming the divisions between the hammers.
Birch........	,,	Canada...... ...	Belly-rail, a part of the framing.
Cedar........	,,	South America	Round shanks of hammers.
Lime tree...	,,	England.........	Keys.
Pear tree...	,,	,, ...	Heads of dampers.
Sycamore....	,,	,, ...	Hoppers or levers, veneer on wrest-plank.
Ebony.......	,,	Ceylon...........	Black keys.

MATERIAL.			WHERE USED.
Spanish Mahogany...	„	Cuba	For decoration.
Rosewood...	„	Rio Janeiro..	For decoration.
Satin wood.	„	East Indies..	For decoration.
White holly	„	England......	For decoration.
Zebra wood	„	Brazils.......	For decoration.
Other fancy woods...............			For decoration.
Woollen fabrics.			
Baize;—green, blue, and brown..			Upper surface of key-frame, cushion for hammers to fall on, to damp dead parts of strings, &c.
Cloth, various qualities............			For various parts of the action, and in other places to prevent jarring; also for dampers.
Felt			External covering to hammers.
Leather.			
Buffalo................................			Under covering of hammers,—bass.
Saddle			Under covering of hammers,—tenor and treble.
Basil			Various parts of the action.
Calf			Various parts of the action.
Doeskin................................			Various parts of the action.
Seal................................			Various parts of the action.
Sheepskin................................			Various parts of the action.
Morocco................................			Various parts of the action.
Sole................................			Rings for pedal wires.
Metal.			
Iron................................			Metallic bracing, and in various small screws, springs, centres, pins, &c. &c. throughout the instrument.
Steel			Metallic bracing, and in various small screws, springs, centres, pins, &c. &c. throughout the instrument.
Brass................................			Metallic bracing, and in various small screws, springs, centres, pins, &c. &c. throughout the instrument.
Gun metal................................			Metallic bracing, and in various small screws, springs, centres, pins, &c. &c. throughout the instrument.
Steel wire................................			Strings.
Steel spun wire........................			Lapped strings.
Copper covered wire................			Ditto,—lowest notes.

MATERIAL.	WHERE USED.
Various.	
Ivory	White keys.
Black lead	To smooth the rubbing surfaces of cloth or leather in the action.
Glue (of a particular quality, made expressly for this trade)	Woodwork throughout.
Bees' wax, emery paper, glass paper, French polish, oil, putty powder, spirits of wine, &c. &c.	Cleaning and finishing.

The materials must all be of the best possible quality. The timber especially, being the most important, must be selected of the soundest description; it requires to be thoroughly seasoned (a process of several years' duration), and must then be dried by artificial heat before it is worked for use. A similar degree of care must be taken in the selection and preparation of all the other materials, or the quality of the instrument will suffer.

In comparing the French pianos exhibited at the Paris Exhibition of 1849, with the British pianos presented for exhibition on the late extraordinary occasion, we observe one curious fact, which we must presume to be ascribed to the fact that in this country the manufacture is limited to a small number of great capitalists, while in France it is distributed among a much greater number of makers working on a smaller scale. With a manufacture upon less than half the scale, and without the stimulus offered by unlimited, or indeed any foreign competition, there were in the Paris Exposition nearly ninety exhibitors; while, with all the extraordinary excitement presented by the World's Fair, the Crystal Palace only produced, according to the catalogue now before us, thirty-eight native exhibitors.

The following statement shows the proportion in which 173 piano-fortes exhibited, were supplied by the industry of different countries: —

	Exhibitors.	Piano-fortes exhibited.
Great Britain - - - -	38	68
France - - - - -	21	44
Belgium - - - - -	6	14
Germany (Zollverein, &c.) - - -	18	24
Austria - - - - -	5	5
Switzerland - - - - -	3	3
Denmark - - - - -	1	2
Russia - - - - -	1	2
United States - - - -	6	9
Canada - - - - -	2	2
Total - - - -	101	173

No department of the Exhibition has produced more fierce and long-continued polemics among the Exhibitors than that to which our attention is now directed. The decision of the high authorities to whom the award of the honorary medals was confided, has excited reclamations of unusual violence on the part of the unsuccessful candidates for these distinctions, and some unworthy attempts have been made to prostitute the sacred functions of the public press to the gratification of private and personal feelings. Nor have these unbecoming attacks been limited to the parties on whom the envied honour has been conferred. They have been aimed without scruple at the eminent persons, selected from the most exalted scientific and artistic illustrations of every country, for the discharge of the onerous and invidious duty of deciding without appeal between the claims of rival inventors and rival nations. This is deeply to be regretted, not for the sake of those distinguished individuals, who are placed far above the range of such petty weapons, but for the sake of those firms, respected and respectable, which have been so ill-advised as to resort to measures betraying nothing but their sense of disappointment, and only enhancing the value of the honorary distinction which they attempt, in a spirit so puerile, to depreciate.

Long before the award of the juries was made, and even before they had entered upon their inquiries, it became our duty, as public journalists, to review various departments of the Great Exhibition, and among the rest, that of piano-fortes, so far, at least, as this class of musical instruments derived their qualities from the successful application of scientific principles. We discussed the merits of the different systems of construction, indicated the improvements which have been introduced into the mechanism, and assigned to the inventor of the most important of these that credit which is due to one who found the piano an imperfect and left it a nearly perfect instrument. We explained the grounds of this judgment as fully as was consistent with those limits which must always be imposed on such articles in a journal like the *Times*, the columns of which are daily crowded with matter so various and important. This judgment of ours, conscientiously formed, and freely expressed, was denounced by those with whose interests it clashed, and was attacked without scruple or measure, directly and indirectly, through the instrumentality of the press. It nevertheless eventually received a signal sanction from all the several juries to which the arbitrament of the rewards was assigned by the Royal Commission. Whatever other differences may have prevailed between one jury and another, there was none as to the title of the inventor we indicated, to the highest class of honorary distinction.

We shall now resume this subject with the advantages of less restricted space for its discussion, and more time for that mature consideration which it both requires and deserves, than was compatible with the circumstances under which our former review was written.

The musical sounds which issue from all stringed instruments are produced by imparting vibration to elastic strings extended tightly over a case or box covered over with thin

boards of vibratory wood, which aid the development of the sound as well by their own vibration as by that of the volume of air which they enclose.

Such instruments differ one from another in the material, thickness, length, and number of the strings, and in the manner of throwing them into vibration.

In some, the strings are gut, as, for example, in harps and violins; in others they are wire, as in piano-fortes. In some their length is varied at will by the imposition of the finger of the player, each string being capable of producing many different notes; violins, guitars, and other instruments of the same class, are examples of these. In others the strings are of determinate and invariable length, each producing only one note. The harp holds an intermediate place between these classes, being provided with mechanical expedients, by which each string is capable of producing three notes, the flat, the natural, and the sharp, by varying its length, which is effected by pedals, and certain mechanism connecting them with the stops.

Stringed instruments differ also from one another in the manner whereby the strings are thrown into vibration, and by which the vibration is suspended. In some the finger of the performer, applied directly to the string, draws it from its position of rest, and suddenly disengages it. Harps and guitars are examples of this class. In these, no other provision is made to stop the vibration save the application of the hand. In the class of instruments which come under the general denomination of violins, including violoncellos, &c., the vibration is produced by friction applied to the string by means of a bow previously prepared with rosin, which is pressed upon the string and moved transversely to it. No provision is made in this class of instruments to stop the vibration other than the application of the finger.

In the case of the piano-forte, the wire string is thrown

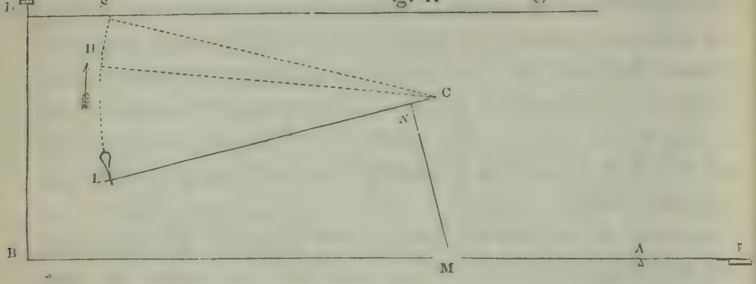
into vibration by a blow given to it by a hammer coated with soft leather, such hammer being impelled by the finger of the performer through the intervention of certain mechanical arrangements which we shall presently describe. The vibration is suspended by a soft cushion of cloth, called a *damper*, attached to the end of a vertical rod which presses upon the string. So long as the vibration is to be continued, this damper is kept away from the string by mechanism connected with the key. The same action of the finger which produces the vibration, governing this damper, also regulates its continuance.

When it is considered that all the delicacies of expression and articulation, and all the lights and shades of the performance depend upon the precision, certainty, and promptitude with which the hammer responds to the touch of the finger, the immense importance of the mechanism of the key will be duly appreciated. Yet it is a curious fact in the records of the progress of this instrument, that the mechanism of the key has been the last part of it to which invention has imparted perfection; and that, even at the present time, notwithstanding the advanced state of the musical art, and the all but universal cultivation of the piano-forte, the key mechanism, in a very large proportion of the instruments in circulation, is constructed on imperfect principles, and is, consequently, productive of unsatisfactory effects.

To explain all the requirements which must be fulfilled by a perfect instrument, it will be convenient to notice the several stages of improvement through which the mechanism of the key has passed, thus rendering more clearly manifest the defects which have presented themselves, the exigencies of the performer arising either from improved powers of execution, or an improved style of musical composition, and the various difficulties which have been presented to, and happily surmounted by, piano-forte makers.

Let F B, *fig.* 1., represent a lever, at one end of which is the key F, upon which the finger of the performer acts. Let A be the centre upon which this lever plays. Let M N be a rod,

Fig. 1.



called by piano-forte makers a *jack*, which is jointed to the key at M, and which we will suppose, for the present, is also jointed to another lever C L, playing upon a centre C, and to which, at the extremity L, the hammer is attached, the hammer-head being composed of a small oval nob covered with soft leather. When the key is depressed by the finger at F, the jack M N is raised, and by its action lifts the hammer C L, which plays in the arc L S, and when the key is sufficiently depressed, the hammer L will strike upon the string S S′. Now, if the finger were maintained upon the key so as to keep the hammer in contact with the string after striking it, no vibration would be produced, since the hammer continuing in contact with the string, would act as a damper. To produce vibration, it would therefore be necessary that the moment the hammer strikes the string it should recoil from it, and not return to contact with it so long as the vibration continues.

Such an arrangement as is here indicated could only be accomplished by the performer suddenly withdrawing the finger from the key the moment the stroke of the hammer on the string takes place.

This, which was called a *key without escapement*, was the first form in which the mechanism was constructed. It was soon found that the action required by the finger was incompatible with a satisfactory effect. It was necessary to allow the finger to continue upon the key without stopping the vibration, and at the same time to establish a connection between the key and the damper, by which the latter might be regulated in its action upon the string in such a manner that, so long as the finger might hold the key depressed upon its bed, the damper would be raised from the string so that the vibration might continue. This was accomplished by a simple modification in the connection between the jack M N, and the hammer C L. It was so arranged that, when the key was depressed to its bed, the jack M N raised the hammer-head only to a point H, within about an eighth of an inch of the string. The blow upon the string was produced not by the immediate action of the key, but by projecting the hammer-head upwards from the position H to the string. The arm of the hammer was, in short, not jointed to or connected with the jack M N. This jack merely supported the hammer without being jointed to it, so that, when the hammer was brought quickly up by the jack from L to H, it deserted the jack at C H, flying upwards with the momentum it had acquired in moving from L to H, and striking upon the string with a corresponding force.

It is evident that the energy of the blow thus given to the string, and therefore the loudness or intensity of the note produced, must, under the circumstances here supposed, depend solely on the force with which the hammer is projected when it leaves the jack, and with which it moves from H to S. But this force will depend altogether on the velocity with which the hammer has been moved from L to H, or, more strictly, upon its velocity at the moment it leaves the jack at H. The greater this velocity is, the greater, in the same

proportion exactly, will be the force of the blow given to the string, and the consequent loudness of the note. Thus, if the note produced when the hammer is raised from L to H in half a second, have a certain intensity, it will have double that intensity when the hammer is raised from L to H in a quarter of a second.

Whatever be the mechanism by which the action of the finger is transmitted to the hammer, the pressure of the finger in depressing the key, so far as the hammer is concerned, must always be determined by the relative spaces which limit the play of the key and that of the hammer respectively. Thus, if to raise the hammer from L to H, it be necessary to depress the key through a space equal to one-fifth of L H, then the pressure of the finger upon the key must be exactly five times the weight of the hammer, exclusive of a small amount of force necessary to overcome the friction on the centres of the several levers. This principle is so elementary, that we should not have thought it necessary here to state it so expressly, if we did not know that it is frequently overlooked or mistaken in the workshops of the makers.

Let it therefore be well understood, that the force or loudness of the note does not and cannot depend upon the greater or less pressure exerted by the finger upon the key, inasmuch as that pressure cannot be varied at the will of the player, but that it depends solely, other things being the same, upon the time taken to depress the key from the general level of the key-board to its bed. So long as the time taken to depress it is the same, the force or loudness of the note produced will be the same, whether the key be depressed by the finger of an infant or by the finger of a giant.

To return, however, to the action on the string, it must be observed that, when the hammer, projected upwards from the jack, has given the blow to the string, it will immediately recoil from it, partly by the effect of its weight, and partly

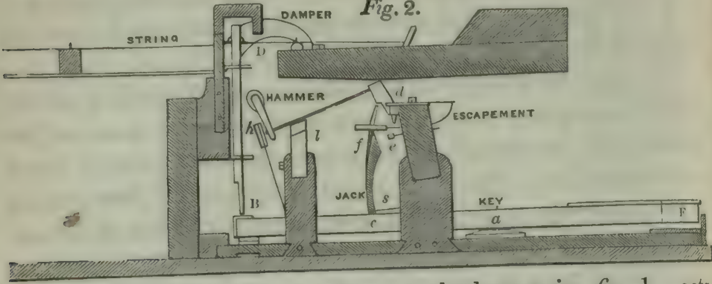
by the reaction of the string upon it, just as a tennis-ball would rebound from the wall which it strikes. Now, if in this case, the arm of the hammer fell back upon the jack M N, it would again rebound from it, and, returning to the string, would instantly make a second stroke upon it, and this would be followed by a third stroke, and so on. The effect of this would be a jar. To prevent this, the mechanism is so arranged that, on the recoil of the hammer from the string, the jack M N so shifts its position that the lever C L does not fall back upon it in such a manner as to rebound from it, but is held down by a peculiar provision, which we shall presently notice. This arrangement, which allows the hammer on its recoil to descend without again encountering the jack, is called *an escapement*.

The principle upon which the key works the damper is represented in *figs*. 1. and 2. at B D. The vertical rod B D supports, upon its upper extremity D, a soft cushion of cloth, which, when the rod B D is not elevated by the key, rests upon the string and prevents vibration. When, however, the key is depressed by the finger at F, the extremity B is raised, and presses up the vertical rod B D so as to raise the cushion D from the string and permit the vibration. In this manner, so long as the finger is kept upon the key at F, the damper D is raised from the string. When the finger is withdrawn from the key at F, the end B falls, and allows the damper to return to the string and stop the vibration.

Such are the general principles upon which the mechanism of the key was constructed, and which continued in general use until 1821. This arrangement with all its accessories is represented in *fig*. 2. The several parts are so clearly designated in the diagram, that after the explanation we have given above, no difficulty will be found in comprehending their action.

The centre on which the key plays, is at a. The *touch*, or the ivory surface to which the finger is applied, is at F. The

Fig. 2.



jack $c\,f$, corresponding to that marked M N in *fig.* 1., acts directly upon a notch formed in the butt d of the hammer. The hammer, when the key is not depressed, rests upon a rail at l, which is covered with cloth to render its fall noiseless. When the key at F is depressed to its bed by the finger, the jack $c\,f$, acting in the notch, raises the hammer to such an elevation that its head comes within about the eighth of an inch of the string. When the hammer arrives at this position, the inclined plane formed upon the jack at f, coming in contact with a fixed pin e, is driven by the reaction of this pin out of the notch; but at the moment this happens, the hammer, having received in its ascent a certain momentum, flies upwards and gives the blow to the string. When it recoils, the jack having been driven back by the pin e, is in a position to the left of the notch, and therefore does not receive the hammer, which falls to a lower point, and is received upon a check h, the point of the jack passing into the angle formed by the handle of the hammer and by its butt d. The check h is covered with soft leather to render the fall of the hammer head upon it noiseless. It is evident that in the position of the parts here described, the hammer cannot receive a second stroke, inasmuch as the point of the jack has

not entered the notch. But when the finger is removed from the key, the latter rising to the general level of the key board, the end *c* falls, and the jack is drawn to the right by a spring *s*, so as to be brought again into the notch preparatory to another stroke of the key.

The mechanism of the damper is represented at B D. It consists, as already described, of a vertical rod, B D, moving in guides, and elevated by the key lever placed under the lower extremity of B. When the key is not depressed, the cushion of cloth rests upon the string with its weight at D. When the key lever is depressed at F, the end B is elevated, driving up the vertical rod B D, and raising the damper from the string.

The combination of the inclined plane *f*, the fixed pin *e*, and the notch formed in the butt *d* of the hammer, constitute the *escapement*, so called because by their operation the point of the jack *escapes* from the notch, and is driven back to the left, so that on the return of the hammer from the string, it cannot again fall into the notch.

It will be evident, on considering the effect of this mechanical combination, that when once the point of the jack projects the hammer to the string, a second impulse cannot be given to the hammer by the key, until the point of the jack is again brought into the notch, which it cannot be until the hammer, the key, and the jack have severally returned to their places of rest, that is to say, until the key F returns to the common level of the key board.

One of the most obvious defects which this arrangement presents, is the limit which it imposes on the rapidity with which the same note can be successively reproduced. To strike the same note twice in succession, it is necessary that before the second action of the finger, the key be allowed to rise from its bed to its position of rest, that is, to the general level of the key board. Now, although the per-

former can at will depress the key with more or less celerity, he has no control whatever over the promptitude with which it rises from its bed to the level of the key board.

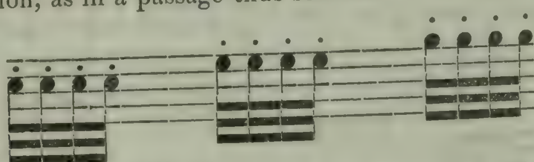
To make this more clearly understood, let the time taken by the finger to depress the key to its bed be expressed by D, and let the time necessary for the key to rise from its bed to the general level of the key board be expressed by R. If, then, we express by I the interval which must elapse between two successive repetitions of the same note, we shall have

$$I = D + R.$$

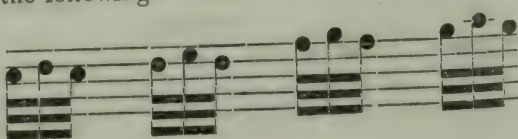
Now, over the time expressed by D, the performer has a control limited only by the agility of his finger; but over the time expressed by R, he has no control whatever.

It follows, therefore, that this mechanism imposes an impassable limit on the interval I, which must elapse between two successive repetitions of the same note, one part of this interval, viz., that expressed by R, being beyond the control of the performer.

The limit thus imposed on the executant, must not, however, be imagined to be confined to the case in which the same note is required to be repeated rapidly in uninterrupted succession, as in a passage thus set: —

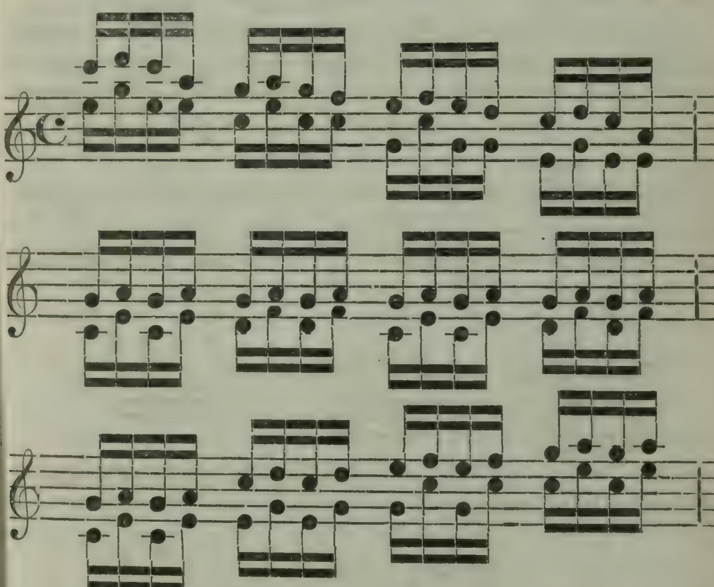


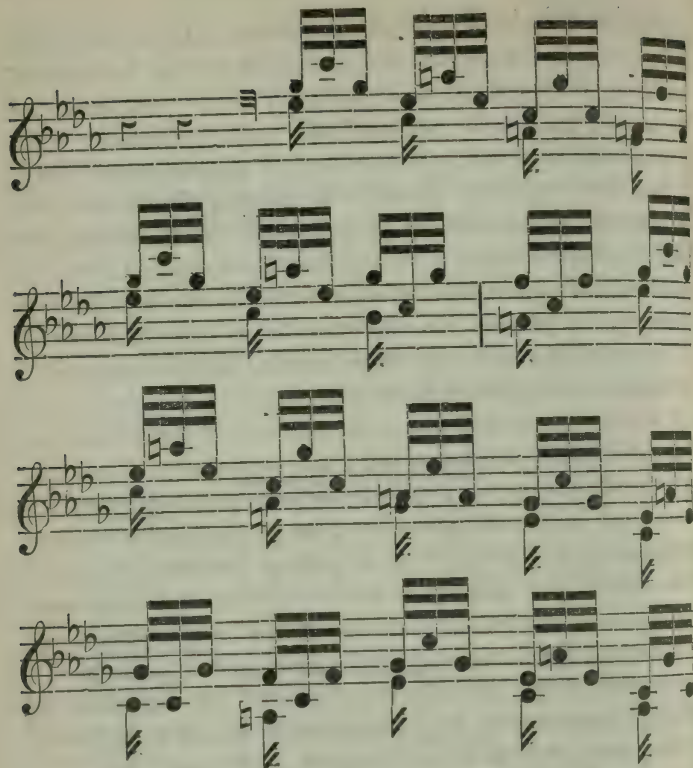
It also limits the rapidity of the execution of passages such as the following: —



For although, by the due management of the fingers, any two of the notes, in passages of this kind, which are in immediate succession, may be produced with any desired rapidity, three certainly cannot; inasmuch, as to produce three such notes in succession, the same key must be always put down twice successively, and to the rapidity with which this can be accomplished, there is the impassable limit already explained.

In following out this reasoning, cases without number will occur to the pianist, in which his execution must be fettered by the mechanism of the key. The following may be taken as examples of this : —





In fine, a shake, and certain other graces of the pianist, in which the same note, though not uninterruptedly repeated, requires to be put down at very short intervals, cannot be executed with a rapidity exceeding that limit imposed by the insurmountable necessity of allowing the time R, necessary for such key to rise to its position of rest, before it can be again put down, so as to produce a note.

But there is still another difficulty which results from this mechanism, as a less immediate, though not less inevitable con-

sequence. In order to reproduce the same note even with that limited celerity which is compatible with the mechanical conditions of the escapement, the key must be put down with the utmost practicable promptitude, and the hammer must be projected against the string with a proportionate speed. It has, however, been already shown, that the intensity or loudness of the note will be proportionate to the speed with which the hammer is projected against the string. It follows, therefore, that wherever this rapid action of the key becomes necessary, the passage must be executed as if it were marked *fff*, however opposed this effect may be to the character of the music, or the design of the composer.

It would appear in theory, that this vice of the mechanism might be obviated by suppressing the escapement altogether, and investing the performer with the same power of returning the hammer to the string, as he possessed in pianos without escapement. But to such an expedient insuperable objections existed; and it was felt by all makers to be necessary to retain that system of action which attacked the string by projecting the hammer from a point, such as H, *fig.* 1., at a certain small distance from it, and for this mode of action an escapement is indispensable. It was therefore necessary to supersede the escapement above described, without abandoning the manner of attacking the string by the projection of the hammer from the jack, and at the same time to connect the key with the hammer in such a manner, that when the latter recoils from the string after the blow, it shall not escape from the jack so irretrievably that the jack may not immediately recover its power over it, without waiting for the hammer to descend upon its resting rail.

All these difficulties were surmounted, and all these objects fully attained, by a mechanical combination due to the invention of the late Sebastian Erard, who had already ren-

dered his name so memorable in the history of the musical art, by the improvements he had effected in the structure of the harp,—an instrument, indeed, which, as it now exists, may most justly be pronounced to be the creature of his invention, and to have attained a degree of perfection which it is not likely to exceed.

M. Erard had been, before the epoch now alluded to, known in England only as a harp maker. It is true that, in connexion with his brother, he had for many years carried on a manufactory of pianos in Paris, and had thoroughly studied the mechanism of that instrument. From his intimacy with the great pianists of that day in every part of Europe, and more especially with Dussek and Steibelt, he became fully acquainted with the defects under which the piano laboured, and with those new powers, the want of which had hitherto crippled the executant, and circumscribed the genius of the composer. Happily for the progress of the art, that inventive spirit which had already perfected the harp, did not fail before the still more difficult problem presented by the piano-forte. We recollect nothing in the history of mechanical invention which, for simplicity and beauty of principle, for promptitude, certainty, and efficiency of action, and for smoothness and durability under incessant operation, can be compared with the key mechanism due to this accomplished artist, except the parallel motion of Watt, to which, indeed, without any thing common in principle, it bears a striking analogy.

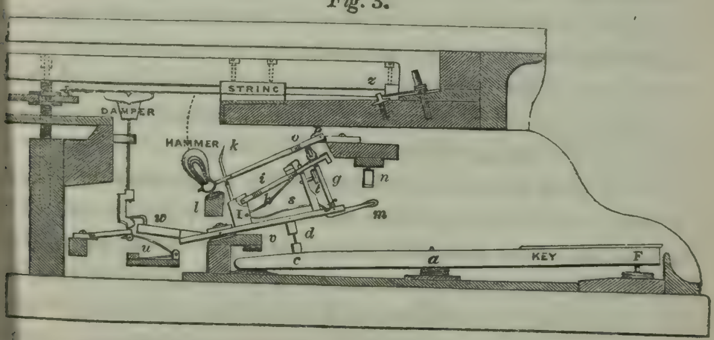
Watt used to say, that after he had conceived the parallel motion, and reduced it to a drawing, the performance of its first model was viewed by himself with the same sense of agreeable surprise, and the same enjoyment at the precision and efficiency of its action, as if he had not been its inventor; and that, in its practical effects, numerous precious qualities

were developed, which he either did not foresee, or was not conscious of while its invention was being elaborated in his mind. He could not even explain to the men of science who crowded round him to tender the homage of their admiration, by what intellectual process he was led to the invention.

Thus it is almost invariably with mechanical inventors of the highest order. Theirs is an instinct. They frequently arrive at their ultimate combination *per saltum*, not step by step, as in the discursive and inferential processes of the philosopher. Yet when tested by the principles of science, and submitted to the most severe analysis, their inventions generally bear the indications of laborious thought and cautious foresight, and are frequently, as in the example of the parallel motion, and doubtless, also, in that of the mechanism of the key, fertile sources of consequences and qualities of the highest value and importance, which even the inventor himself had not expected.

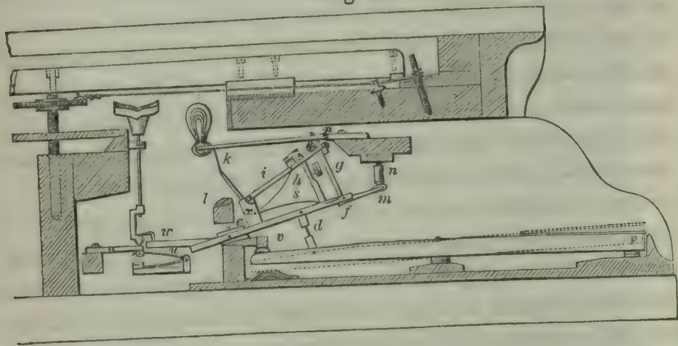
The key mechanism invented by Sebastian Erard, and published and patented in 1821, is represented with all its details in *figs.* 3. and 4. In *fig.* 3. the key is in its position

Fig. 3.



of rest, not being yet depressed below the general level of the key board. In *fig.* 4. the hammer is represented after it has given the blow to the string, and has fallen back upon the check *k*, preparatory to another blow.

Fig. 4.



One of the objects of the inventor was to enable the executant to repeat the blow without allowing the hammer to fall down upon its bearing *l*, which, as has been already explained, was indispensable in the old action. This new mechanism was so contrived, that it was not necessary to let the hammer fall down on its bearing *l*, but that the key should have a complete and uniform command over the hammer throughout its entire play between its lowest position, which it has when the key is not depressed at all, and the highest position, when the key is depressed completely down upon its bed. Throughout the whole of this arc, corresponding to that represented in *fig.* 1. between L and H, not only has the finger the most absolute power over the hammer, so as to be capable of throwing it up to the string from any point in the entire range of its play, but this power is mathematically uniform and absolutely certain in its effect. The note can be produced, to use an appropriate phrase

derived from steam machinery, either at *half stroke*, at *quarter stroke*, or, in a word, at any fraction whatever of the entire stroke of the key.

We consider it the more necessary to insist on this point here, inasmuch as the designation of *double escapement*, which has been given to this mechanism, implies that there are only two points in its play from which it can be projected with effect upon the string. This, if true, would render its powers much more limited than they are. There is, in effect, no point in the entire play of the touch, no fraction, however small, of the entire stroke of the key, which is not sufficient to reproduce the note. In the nomenclature of patent inventions, the prevailing quality is a puffing exaggeration of the claim. It is rarely that we have to take exception against a title for implying qualities short of those which the invention really possesses.

The same exception may to some extent be taken to the title of *repetition action*, by which this mechanism has been generally designated in England. It is true, as will presently appear, that it has a repeating power which is absolutely without limit, but this is not its only, nor perhaps its most valuable quality. In this key mechanism, the jack acts upon the hammer in a manner totally different from that already described, in which the point of the jack falls into a notch, by acting on which the hammer is projected upwards. In the present case there is neither butt nor notch constructed on the arm of the hammer; but at a point placed at a certain distance from the joint p (*fig.* 3.), on which the hammer plays, and under the arm, there is attached at o, a *small roller*, upon which the point of the jack g is directed centrically, in the same manner as the point of a billiard cue is directed upon the ball when the player desires to make a full stroke. This

roller is represented on a larger scale in *fig.* 5., where p is the joint on which the hammer plays, and o is the roller just described, g being the jack which is represented as directed to the centre of the roller, and at right angles, or nearly so, to the handle of the hammer. The motions of the jack g, and the roller o, are so governed by the mechanism, that while the hammer ascends, the jack is continually directed to the centre of the roller, and there exercises upon it a uniform power until the hammer rises to the highest point of its play, as represented in *fig.* 6. At this moment it is projected upwards from the jack, and a part of the mechanism, which will be presently described, moves back the jack from g to g' (*fig.* 6.), so that after the recoil of the hammer from the string, the roller o does not return to the head of the jack, but is supported by a lever represented at i (*figs.* 3. and 4.), acted on by a spring.

Fig. 5.

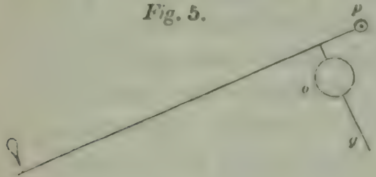
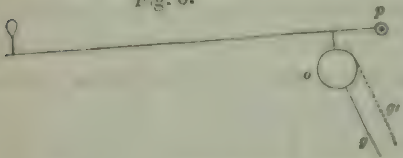


Fig. 6.



The hammer being now ready to make another stroke, though it has not yet descended from the highest point of its play, a spring s, attached to the block r (*figs.* 3. and 4.), draws back the jack from the position g' (*fig.* 6.), to the position g, the roller o being sustained in its position during this motion by the lever i, which lever is acted on by a spring.

When the jack comes back to the position g, it resumes its entire power over the hammer, so that a second stroke

can be made when the key is allowed to rise from its bed through the smallest fraction of the entire stroke.

The position of the hammer represented in *fig.* 6., is that which it has in *fig.* 4., after having fallen back from the string; but the jack g, in *fig.* 4., has the position indicated by the dotted line g', in *fig.* 6.

When the key F is relieved in the slightest degree from the pressure of the finger, the jack g moves from the position indicated in *fig.* 6. by g', to the position indicated in the same figure by g, the *hammer during this motion not descending from its position.* After this, if the key be allowed to rise through the smallest fraction of the stroke, the hammer will descend through a corresponding fraction of its play, the *jack always holding its position centrically under the roller,* and the finger, therefore, whatever may be the extent to which the key is allowed to rise, *having always a complete command over the hammer, and a complete ability to reproduce the note.*

To explain the mechanism by which these effects are produced, we must observe that the key F, having its pivot at a, acts upon a jack d, in the same manner as in the old mechanism. This jack d does not, however, act immediately upon the hammer. Between them is interposed a combination of levers and springs represented in the diagrams. The jack d acts immediately on the intermediate lever f, which has its pivot at e. To this lever is attached, at f, a second jack g, from which a rectangular arm $f\,m$, projects. This second jack g sustains the hammer by acting *centrically* on the roller o, already described. When the key F is depressed by the finger, the lever $e\,f$, the rectangular jack, the roller o, and the hammer, are severally raised. When the hammer head is brought within about the eighth of an inch of the string, the end m of the arm of the rectangular jack is

brought to bear against the fixed pin *n*, as represented in *fig.* 4., by the reaction of which, the rectangular lever is turned on its centre *f*, so as to take the head of the jack from under the roller *o*, which last is at this moment dismissed from the jack *g*, and the hammer is projected against the string. When the hammer recoils from the string, the roller falls back upon the lever *i*, which is urged upwards by a spring *h*, so controlled in this upward reaction by another point of contact brought about between the spring *h* and the hammer, that the latter cannot rebound again to the string. Meanwhile the jack, no longer centrically under the roller, has assumed the position with respect to the latter indicated by the dotted line *g′*, in *fig.* 6. When the finger relieves the key F slightly of its pressure, the rectangular arm *f m* is released from the reaction of the pin *n* ; and the spring *s*, acting upon the jack *g*, draws it back so as to bring it again under the roller, the roller itself meanwhile being sustained with the hammer by the lever *i* acting upon it by the spring *h*.

During this operation it is most important to observe, that the hammer is not allowed to fall through any part of its play. Indeed, it slightly *rises* by the action of the spring *h*, while the jack is being removed from the position indicated by the dotted line *g′* (*fig.* 6.), to the position indicated by the line *g* (*fig.* 6.), in which it resumes its power over the hammer. It is therefore most essential to observe, that while the jack recovers its power over the hammer, the hammer itself does not descend through any portion, however small, of its play.

It appears, therefore, that by this mechanism, the hammer, instead of being placed under a mechanical necessity of recommencing its stroke always from the same point which forms the lowest limit of its play, is capable of imparting to the string a blow from any point whatever of this play, and

thus effects infinitely varied, according to the extent of play given to the action of the hammer, may be produced by the executant.

When it is considered how much all the lights and shades, all the *nuances*, the numerous and nameless delicacies of expression and articulation of the performance, depend on the sensitiveness with which the hammer responds to the finger, and that this sensitiveness is augmented in a ratio almost literally infinite by this mechanism as compared with that which it has superseded, the immense value and importance of the invention may be perceived.

It was these considerations which operated on the jurors and the Council of Chairmen, and formed the legitimate grounds of their decision to confer upon the nephew and representative of the inventor, we may say by acclamation, the highest class of reward which it was in their power to bestow. When the question was raised, whether any other invention could be traced, in the history of the progress of this instrument, which has merited a like honour, it was decided by the Council of Chairmen in the negative.

It remains, however, to explain the action of the key upon the damper in this system. It will be remembered that the old damper acted on the string by its weight at D (*fig.* 1.), and that it was raised from the string by means of the key, so long as the vibration was intended to continue. In the mechanism of the key in Erard's piano, the damper is placed *under* the string instead of *over* it, and the pressure which it exercises is produced by means of a spring *u* (*figs.* 3. and 4.), which acts upon the lower end of the vertical rod upon which the damper is placed.

When the key is depressed by the finger, the jack *d* raises the intermediate lever *e f*, the opposite end of which acts upon the damper at *w*, by means of a shoulder formed upon it, as

represented in the figure. When the short end of the intermediate lever w is thus depressed, it compresses the spring u, and draws down the damper from the string. When the finger is withdrawn from the key, the spring u, relieved from the pressure of the lever w, acts upon the rod of the damper, which it again presses against the string.

The spring damper thus substituted for that which acted by weight, has the advantage of deadening the vibration more suddenly, the old damper being liable to a jumping effect when let down upon the vibrating string.

With a key constructed in the manner here described, the performer can repeat the same notes successively with any desired rapidity. The interval which must elapse between two successive repetitions of the same note, will in this case be composed of the time necessary to let the key rise through a small fraction of its entire play, together with the time necessary to put it down through the same fraction; whereas, in the old mechanism, it was necessary to let the key rise from its bed to the general level of the key-board, and then to put it down. If, therefore, with the improved mechanism, the key be allowed to rise only through one fourth of its entire play, it will follow that the interval between two successive repetitions of the same note with the old mechanism will be four times as great as the interval with the improved key; in other words, the rapidity with which the same note can be repeated with the improved key, will be four times greater than with the old key.

But rapidity of repetition is not the only advantage attending this mechanism. It has been already observed that rapid passages, where the same note must be put down at very short intervals, must necessarily be played *forte* with the old key, inasmuch as, to execute them with the desired rapidity, the hammer must receive great velocity. Now, in

the improved key, such passages can be executed with any desired degree of *piano* effect, inasmuch as the keys, not being allowed to rise through more than a small fraction of their play, the notes can be produced and reproduced with any desired rapidity, while, nevertheless, a very moderate velocity will be imparted to the hammer. Thus any degree of *piano* effect is rendered compatible with any degree of *rapidity* of execution.

It has been observed that, with the old mechanism of the key, a very rapid shake must necessarily be executed *forte*. With the improved key, any degree of rapidity may be imparted to the shake compatibly with any degree of *piano* effect, since it is only necessary to work the two keys producing the shake through a small fraction of their entire play.

In estimating the weight of the touch, or the amount of the pressure exercised by the finger in putting down the keys of a piano-forte, we have frequently observed that the makers and their operatives entertain notions not compatible with the exact principles of mechanical science. It may not, therefore, be without utility here to explain briefly the conditions which determine the weight of the touch.

The weight of the touch arises from the following causes:—

1. The effect of the weight of the hammer.

2. The effect of the weight or reaction of the damper.

3. The effect of the preponderance of the key mechanism against or in favour of the finger, as the case may be.

4. The friction of the key mechanism.

Since the strings in different parts of the scale require a different degree of force in the action both of the hammer and the damper, it is evident that the effects of these will be different. The weight of the touch will necessarily in-

crease towards the lower and diminish towards the upper octaves.

In the key mechanism of Erard, adjustments are provided by which the weight of the touch can be varied, so as to be adapted to the style or finger of any performer.

The effect produced by the weight of the hammer may be computed as follows:—Let H express the weight of the head of the hammer added to half that of the lever which connects the head with the centre on which it plays; let h express the length of the play of the head, measured between its position before the key is depressed, and its position when the key is brought fully down upon its bed; and let k express the fall of the key. The reaction produced by the hammer against the finger will then be $H \times \frac{h}{k}$.

The effect of the reaction of the damper may be determined in like manner. Let D be the weight or pressure of the damper against the string, and let d be the space through which it is moved by the action of the key. The reaction of the damper against the finger will then be $D \times \frac{d}{k}$.

If, then, the preponderance of the key mechanism against the finger, including the friction on the centres, be expressed by p, the entire weight of the touch will consist of the following elements: —

Reaction of the hammer - - - -	$H \times \frac{h}{k}$
Reaction of the damper - - - -	$D \times \frac{d}{k}$
Preponderance of the key lever, and friction -	p.

If T, therefore, express the weight of the touch, we shall have

$$T = H \times \frac{h}{k} + D \times \frac{d}{k} + p$$

for those keys in which the preponderance is against the finger, and

$$\text{T}' = \text{H}' \times \frac{h'}{k'} + \text{D}' \times \frac{d'}{k'} - p'$$

for those in which the preponderance is in favour of the finger.

In estimating the amount of physical power expended in a performance, it would be necessary to take into account not only the pressure here calculated arising from the reaction of the hammer and damper, and the preponderance of the key, but also the force which must necessarily be expended on the inertia of the matter composing the mechanism which is interposed between the finger and the hammer. This matter receives from the action of the finger a certain momentum or moving force, to calculate the amount of which is not difficult when the weight, form, and play of the several levers are known. Our limits, however, do not allow us to enter into the details which such an analysis would involve, and we shall merely observe that the lighter the mechanism is by which the action of the finger is transmitted to the hammer, the less will be the expenditure of power on the part of the performer. It would be a great error to assume that, because the mechanism of the key is very accurately balanced, the physical power expended is the same, whether the mechanism be heavier or lighter. This would be equivalent to assuming that the materials of such mechanism are divested of inertia.

Even in instruments the least perfect, the touch is so light that it might appear a speculative rather than a practical question to estimate the expenditure of physical power made by the executant in a piano-forte performance. Nevertheless, if the great artists be consulted, they will admit that such a problem is eminently practical, and that there is not only a

considerable expenditure of physical power necessary for the due execution of an elaborate piece of music, but that this amount of manual exertion is subject to great differences, whether we compare, one with another, different performers upon the same instrument, or different instruments played on by the same performer. In short, the physical power expended in executing a given piece of music on the piano-forte, depends partly on the method of the performer, and partly on the quality and mechanism of the instrument.

As we are here concerned chiefly with the instrument and not with the player, it will be unnecessary to discuss in detail the circumstances which render the performance of different executants on the same instrument, laborious in different degrees. We shall merely observe, that the finger can produce no effect whatever upon the string, except by imparting more or less projectile velocity to the hammer; that this projectile velocity depends solely on the time taken to depress the key to its bed, and that all other action of the finger, hand, or arm, which has not for its effect to depress the key with more or less expedition or promptitude, is just so much power wasted. The player may work his hands and arms, he may raise them a foot high above the key board and throw them down again upon the keys, he may gesticulate as though he were engaged in a herculean task, but the strings will not sympathise with his struggles, and will respond with no more effect than they would if the keys were put down with the same celerity and promptitude by the finger of an infant.

It may perhaps be asked, what then becomes of all the force and momentum which the perspiring executant exhibits in such cases? We answer, that it is expended on the bed of the keys which receive these unavailing and ungraceful

thumps, but that for all musical purposes such force is absolutely wasted.

Apart from the consideration of the peculiar difference of method between artist and artist, the measure of the manual labour exerted on the instrument is the weight of its touch combined with the play of its keys. Thus, if it be desired to reduce this estimate to exact arithmetical expression, let T express the weight of the touch, k the play of the key, and n the number of notes played.

The labour necessarily expended in the performance will will then be measured by the product

$$n \times k \times \mathrm{T}.$$

That is to say, a product formed by multiplying the weight of the touch by the play of the key, and this again by the number of notes played, expresses the physical power expended by the player.

The weight of the touch, therefore, being assumed to be the same, it will follow that the expenditure of power in the performance of any given piece of music will depend on the play of the keys. Now in all pianos, the keys of which are constructed according to the old mechanism represented in *fig.* 2., the keys must be put down through their full play for each note produced; but in those constructed on the principle of Erard above explained, the keys do not work through their full play, but through various fractions of that play, according to the character of the music, and the skill, taste, and feeling of the performer. Some notes are produced (to borrow the term already taken from steam machinery) at full stroke, some at half stroke, and some at a third or a fourth of the stroke of the hammer. Thus it may happen, that in a piece consisting of 10,000 notes, the average stroke of the keys will not be more than one half their full play. It will

therefore follow, as a consequence mathematically inevitable, that such a piece may be executed with the key machinery of Erard by the expenditure of one half the physical power which would be necessary to execute the same piece with a piano constructed upon the other system.

This will explain satisfactorily the surprising facility of touch which we find in these pianos, a facility which has even been objected to by artists long habituated to the old touch. It is undoubtedly true, that if this improved action present to the performer a much greater facility of producing many of the old effects, and a possibility of executing passages which with the former key mechanism are all but impracticable, it also opens a greatly enlarged field for his practice, and exacts from him a more careful cultivation of his powers, so as to enable him to avail himself of the improved means of execution which are placed under his hands. The more nearly any instrument approaches to perfection, the greater are the skill and precision necessary in using it. The rude manipulation which is sufficient for the use of a common knife would be inapplicable to a razor. While, however, the physical power of the performer is taxed in a greatly less degree by this improved mechanism, the varieties of expression with which he is invested are augmented in an almost infinite ratio. The same note produced at full stroke and half stroke, or at any lesser fraction of the stroke of the key, will have a different musical effect, besides which all those movements of the key may be made with an infinitely varied agility of the finger. In the old key, however, there is but one movement compatible with the production of the note, that is to say the depression of the key through its entire play.

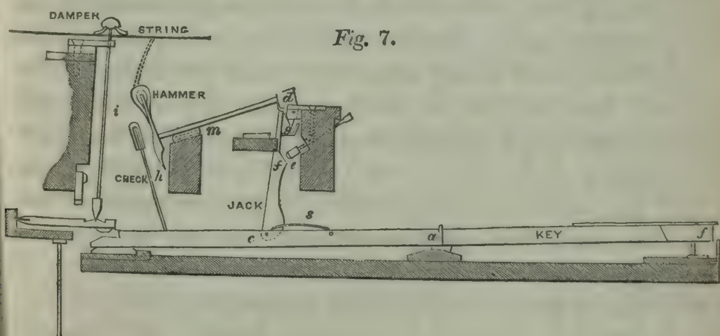
The key mechanism described above was patented by Erard in 1821. It shared the fate of almost all great in-

ventions in the arts. The piano-forte manufacturers, with whose interests it clashed, rebelled against it exactly as did the builders of atmospheric engines against the improved steam engine of Watt. They first attempted to make the public believe that the new mechanism was worthless, and when its value was rendered so evident as to be incontestable, they attempted, by colourable imitations covered by patents, to rob the inventor of the profit as well as of the credit of his invention.

Most of these abortive and distorted copies have, however, fallen into disuse, and the key mechanism which is now most generally adopted by piano-forte manufacturers, is nothing more than a slight modification of the old mechanism represented in *fig.* 2., and already described. Since, however, the numerous and extensive firms which have adopted it, claim for it more or less of those qualities which have been attained in so high a degree by Erard's mechanism, and since the pianos constructed upon the principle are very widely circulated in every part of the world, it is entitled to some notice here.

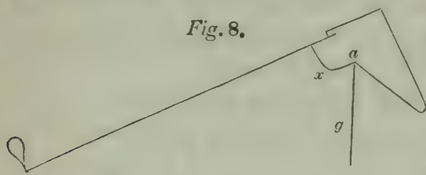
In this key mechanism, represented in *fig.* 7., the jack corresponds very nearly in form and position with that repre-

Fig. 7.



sented in *fig.* 2. There is the same inclined plane at *f*, reacted upon by the same fixed pin at *e*. The butt of the hammer *d*, is modified in its form in the manner represented on a larger scale in *fig.* 8. On the under side of the butt at *a*, an angle is formed to receive the point of the jack, and the corner *x* of the butt is rounded off to facilitate the escape of the point of the jack from it when the hammer is thrown up.

Fig. 8.



To comprehend fully the action of this mechanism, it will be necessary carefully to observe the various positions which the point of the jack assumes, as well while the hammer rises towards the string, as when it returns from it, and falls upon its bed *m* (*fig.* 7.). When the hammer rests upon its bed *m*, and before the key F has been depressed by the finger, the point of the jack rests in the angle *a* (*fig.* 8.) of the butt of the hammer. When the hammer is raised towards the string by the action of the jack at *a*, the point of the jack continues to act in the angle *a* until the hammer approaches within about an eighth of an inch of the string, the corner of the hammer being then nearly horizontal. At this moment the hammer is projected upwards to the string, and the jack, reacted upon by the pin *e*, is driven from *a* to the left. On the recoil of the hammer from the string, the tail of the hammer *h* is caught upon the *check*, the arm of the hammer being then nearly horizontal. In this position the point of the jack is applied to the side of the rounded corner *x* of the butt, as represented in *fig.* 9. When, by gradually relieving the key from the pressure of the finger, the hammer is allowed to descend towards its bed, the

point of the jack passes gradually under the rounded corner x, having the position represented in *fig.* 10., where the hammer approaches very near to its bed m, but has not yet reached it. In fine, when the hammer falls upon its bed m, and not until then, the point of the jack returns home to the angle a, as represented in *fig.* 8.

This movement of the jack back from the position represented in *fig.* 9. to that represented in *fig.* 8., merely depends on the action of the spring s, which draws it in that direction, as indicated in the diagram. When the hammer has descended nearly, but not quite, upon its bed m, and the point of the jack has come to the position, *fig.* 10., under the rounded corner of the butt, another stroke may be given to the hammer. In this case, it will be observed that the point of the jack directed obliquely on the rounded surface of the corner of the butt, acts to mechanical disadvantage, so that a part only of its force is expended in impelling the butt upwards, and a part in slipping over the rounded corner.

Fig. 9.

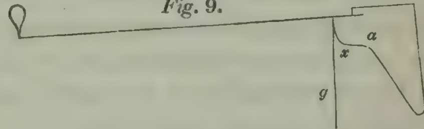
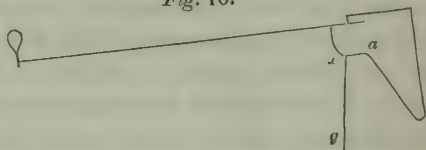


Fig. 10.



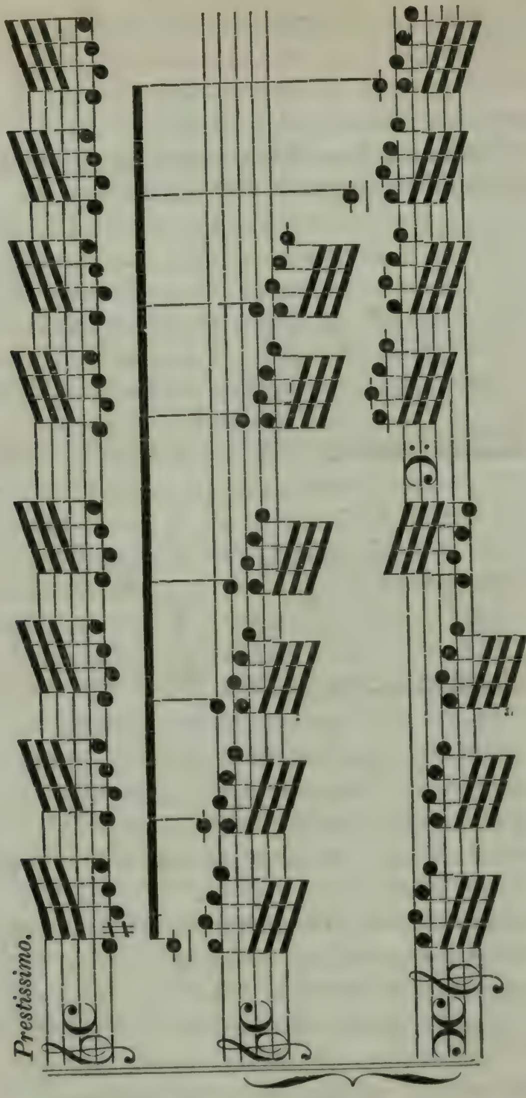
The proportion in which the force imparted to the jack is distributed between these two effects of impulsion and slipping, will altogether depend upon the distance of the hammer from its bed at which the impulsion is given; the greater this distance, the more oblique will be the action of the jack upon the surface x, and the less will be the impulsive force imparted to the hammer.

It will therefore be perceived, that the action in this case must necessarily be faltering and uncertain. If the impulse be given when the hammer is very close to its bed, and therefore the jack in greater proximity with the angle *a*, and its action less oblique, the hammer will be projected to the string with more effect, and will in general strike it, although not with the full force exerted by the finger on the key. If, however, the blow be given when the hammer is at a greater distance from its bed *m*, then the point of the jack will have a greater tendency to slip; a smaller part of its force will impel the hammer, which will in general either fail to strike the string, or, if it strike, it will strike it with a feeble blow, bearing no proportion to the action of the finger or the key.

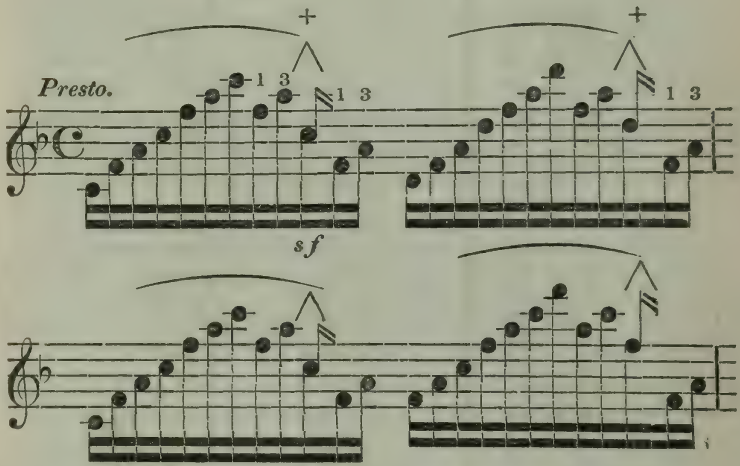
The piano-forte makers who adopt this system, claim for it a certain repeating power, and, indeed, call it a repetition action. To what extent this claim is grounded, will be apparent from what has been just explained. It is clear that the note cannot be reproduced until the hammer has descended so low as to allow the point of the jack to come under the rounded shoulder *x* to such an extent as to give it a sufficient hold upon the butt to project it to the string with the necessary force. Now this, as we have shown, does not happen until the hammer has descended *very nearly to its bed*, and, therefore, until the key has risen to very nearly the general level of the key board. But even then, as has been explained, the effect is faltering and unsatisfactory. If the blow be given before the hammer has descended sufficiently low, it will not receive sufficient force to carry it to the string, and the key will not respond at all to the action of the finger. If it be given when the hammer has descended nearly, but not altogether, to its bed, the blow will be given to the string and the note produced, but with a force alto-

gether disproportionate to the action of the finger on the key,—a portion of this action, as before stated, being lost by the tendency of the point of the jack to slip upon the rounded surface x of the shoulder of the butt.

These inferences, from theoretical reasoning, upon the form of the butt of the hammer, and the mode of directing the jack upon it, appear so obvious and inevitable, that they would scarcely require the corroboration of practical results. Nevertheless, from the respect due to the great manufacturers who have adopted this form of key, we have thought it right to submit our views and reasoning to one of the most eminent living artistical authorities on this instrument, M. Thalberg, and we find our theoretical conclusions fully corroborated by his practical experience. We have put the question to him, whether keys constructed upon this system, being struck repeatedly in such rapid succession as not to allow the time between two repetitions of the same note necessary for the point of the jack to return home to the angle of the butt, after having projected the hammer to the string, respond with certainty and effect to the finger. That eminent artist has in reply assured us, that he has found *that they do not;* although he has not inquired, as we have done, into the circumstances of the mechanism which prevents it. We have requested M. Thalberg to supply us with an example of a passage in which this key cannot be relied on to respond to the finger, and he has given us the following, which he affirms cannot be executed with any certainty of producing the effect intended by the composer on pianos which are not provided with the improved key mechanism of Erard, and he affirms that he would not himself risk the execution of such passages on instruments of the common construction.


Prestissimo.

In the following passage the notes marked thus (∧), struck by the thumb, often do not respond at all, and when they do, do not respond with a force corresponding to the action of the player. In short, M. Thalberg affirms that he could not risk the performance of such a passage on any piano constructed on the common principle.



The tendency of the jack to slip over the rounded corner *x* of the butt of the hammer, and to cause the failure of the note, is increased according as the leather which covers the shoulder of the butt is hardened and rendered smooth by wear.

On comparing the principle of action of this key with that of the old grand action key, of which it claims to be an improvement, we cannot discover any advantages which supply definite grounds of preference. All that the old key professed to accomplish, it does accomplish, and does so with efficiency and full satisfaction to the performer. Whatever

beyond this the key of Messrs. Broadwood and others claims to accomplish, is of the least conceivable advantage to the performer, and even that little it accomplishes with a faltering and uncertain result. It can only claim a repeating power extending through so small a fraction of the full stroke of the key as to be of no practical benefit to the executant, and to give no practical extension to the limits imposed on the composer by the mechanism of the old key. The uncertainty of the action even within the limits of its play, narrow as these limits are, renders it a snare from which the accomplished pianist will shrink rather than risk a failure. Certain that in the execution of some pieces, the string cannot respond to his finger with a force bearing any definite proportion to the energy of his touch, and uncertain whether it will respond at all, he fears to hazard a failure by the use of so imperfect an instrument. It cannot, therefore, be matter of surprise, that pianists such as Thalberg, Listz, Leopold de Meyer, Madame Pleyel, Prudent, Hummel, Mendelssohn, Hallé, and Dreyschok, invariably give the preference to instruments constructed on Erard's system wherever they can be procured, and that some of these artists decline performing on any other.

We are prepared to receive the answer that certain English pianists, such as MM. Sterndale Bennett and Cipriani Potter, while they do not dispute the excellence of the Erard touch, are nevertheless satisfied with the key of Messrs. Broadwood, which we nevertheless pronounce to be defective. Unless, however, it can be shown that these distinguished artists, from whose authority it is most distant from our wish or intention to derogate in the least degree, can perform upon it to the satisfaction of themselves and the public, those compositions which we affirm to be beyond its powers, and which pianists like Thalberg, declare, in corroboration of

our judgment, to be impracticable upon it, we do not see how this can affect the position we have assumed. That certain classes of musical composition can be satisfactorily played on pianos constructed upon the common principle, is undenied and undeniable; but that music of a different class, composed with a view of calling into play the enlarged powers conferred upon the piano-forte by the mechanism of Erard, cannot be satisfactorily, or at all, performed on such instruments, is a proposition which we do humbly conceive that we have established, as well by demonstration based upon the principles of mechanical science, as by the practical results of the experience and skill of some of the greatest living pianists of the modern school.

In the progress of piano-forte music, and in the development of the powers and capabilities of that beautiful instrument, three orders of genius, distinct from each other, and totally different and independent, must be brought into co-operation — that of the executant, that of the constructor, and that of the composer. To each of these a different problem is presented for solution. The first is required to invent methods of manipulation by which the range of power and expression can be extended; the second to invent mechanism, which will render the execution of such improved methods possible; and the third, availing himself of the enlarged powers conferred upon the mechanism by the genius of the one, and the improved methods of execution invented by the other, by which those enlarged powers are brought into practical operation, composes a new order of music, rising as much above former styles of composition as the new mechanism and the new methods of execution are superior to those which preceded them.

A series of instruments chronologically arranged, beginning with the harpsichord, and terminating with the extra grand

piano, which excited so much astonishment and admiration in the Crystal Palace, placed in juxtaposition with a corresponding series of musical compositions, beginning with Corelli, Bach, and Scarlatti, and terminating with the fantasias and concertos of Thalberg, Listz, and de Meyer, would strikingly illustrate this.

The constructor, the executant, and the composer have advanced *pari passu*, each responding to the exigencies of the other, and the instrument, the performance, and the composition have accordingly progressed together. In this, nevertheless, as in all the improvements of the arts, it happens that some individuals are wedded to old methods and averse from innovations. There are musical as well as political conservatives, as opposed to reformers; and we find, accordingly, that some eminent pianists question the excellence of the modern school of composition, and consequently dispute the claims of that improved mechanism, by which alone the compositions of that school can be executed.

It is then undeniably true, that the class of piano-forte music performed by the English artists already named, can be satisfactorily executed on instruments of the ordinary construction; but until these artists affirm that *they can* execute on those pianos what Thalberg affirms that *he cannot*, our position remains unshaken. We repeat that the compositions of the modern school, of which Thalberg, Listz, and de Meyer are types, cannot be executed, so as to ensure the production of the effects designed by the composer, on pianos constructed on the principle adopted by Messrs. Broadwood and other makers who adopt the same mechanism, and we are confirmed in this result of our scientific inquiry by the testimony and the practice of these great artists themselves.

The public, in most of the capitals of Europe, have lately had numerous opportunities of witnessing the surprising and

beautiful effects which characterise the modern school. The performance of Thalberg have been rendered familiar in England by the concerts at Exeter Hall and elsewhere. Listz having been in a great measure withdrawn from the public, by his engagement as chapel-master at Weimar, his place has been most worthily filled by Leopold de Meyer, whose recent appearance in Paris has produced an explosion of enthusiasm, such as we have rarely witnessed. It would be a vain task to describe the marvellous performance of this prodigious master. Under his fingers, the piano becomes a new instrument, and evolves volumes of harmony, which bring it at certain moments into close relation with the organ. The production in a given time of so countless a multitude of notes, would be a mechanical impossibility upon a *clavier* of the common construction.

The *début* of Mdlle. Clauss, which took place this season (1852) in Paris, has been an event of high musical importance, and another evidence of the effects which are placed within the power of the performer by the improved key mechanism. This young artist, who has not yet completed her eighteenth year, has at once taken her place in the foremost rank of her profession. She has surprised the public by the versatility of her talent, executing with equal excellence the works of masters whose styles are characterised by the most opposite qualities. In a single concert, we heard her perform compositions of Thalberg, Listz, Chopin, Bach, and Scarlatti, and found it difficult to say which excited in us greatest pleasure.

Among the performances in which the qualities of the Erard touch have been rendered more than commonly conspicuous, those of M. Quidant merit especial notice. This artist was heard in London for the first time in the Crystal Palace, on the grand piano of Erard's construction which was

placed in the French department. The general admiration excited by him was abundantly attested by the crowds so constantly collected round the performer, in spite of the innumerable objects which attracted attention elsewhere, in the vast area of the Exhibition.

It has been already shown that the manual labour expended in the performance of a piece of music on an instrument the weight of whose touch is T, is expressed by the product

$$P = n \times k \times T.$$

If, in this case, the weight of the touch T be expressed in a fraction of a pound, and the play of the key k in a fraction of a foot, the preceding formula will show the number of pounds' weight which might be lifted one foot high by the manual labour which the performer exerts in executing the piece.

Our fair readers, if any such — attracted, perchance, by the title of this essay — should peruse these pages, will perhaps be astonished when they are told that in the performance of a piece, such, for example, as the fantasia of Thalberg on the prayer in the opera of "Moses in Egypt," on a piano of the common English action, their fingers are actually taxed with an amount of labour which, if applied to lift a weight, would suffice to raise above 84 pounds a foot high! Nevertheless this fact, startling and *bizarre* as it may appear, admits of the most easy, simple, clear, rigorous, and incontestable demonstration.

With the view of ascertaining the comparative labour exacted from the performer by a piano of the common construction, and one made on the Erard principle, we have made some experiments to determine the weight of the touch in each instrument, and to trace the mechanical causes to which the difference so strikingly manifested between them is

to be ascribed. It must be observed, that the instruments are usually so adjusted, as to give an increasing weight of touch in descending on the scale, the touch in the bass being heavier than in the treble. For the purpose of comparison, we have, therefore, taken two corresponding keys in the fourth octave, and have obtained, by accurately conducted experiments, the following results:—

For the common key,

$$\text{H} \times \frac{h}{k} + \text{D} \times \frac{d}{k} = 758 \text{ grs.}$$

$$p = 230 \text{ grs.}$$

The preponderance p, being against the finger, the total weight of the touch was, therefore,

$$\text{T} = \overset{\text{grs.}}{758} + \overset{\text{grs.}}{230} = \overset{\text{grs.}}{988}.$$

In the case of the Erard key, we found

$$\text{H}' \times \frac{h'}{k'} + \text{D}' \times \frac{d'}{k'} = 742 \text{ grs.}$$

$$p = 125 \text{ grs.}$$

and the preponderance p' being in this key in favour of the finger, the total weight of the touch was

$$\text{T}' = \overset{\text{grs.}}{742} - \overset{\text{grs.}}{125} = \overset{\text{grs.}}{617}.$$

It appears, therefore, that the Erard touch is lighter than the common touch, in the ratio of 3 to 5.

But it has been already explained that, independently of the weight of the touch, the force expended by the finger on the inertia of the matter composing the key mechanism, must be also taken into account. A complete mechanical and mathematical analysis which would involve the estimation of the moment of inertia of each lever playing on its proper centre, and which would give the exact result of the entire combination, would require complicated mathematical formulæ, unintelligible to most of the readers of this volume,

and incompatible with its objects. Every practical purpose, however, will be served by ascertaining exactly the weights of the several parts of the key mechanism, as well in the instrument of the common construction as in that of Erard. We have accordingly done this, with all the necessary precision, for two keys taken at the same point near the middle of the key board, and the following is the result: —

KEY 63 ON THE SCALE.

	Common Key.	Erard's Key.
	Grains.	Grains.
Key with spring and check upon it - -	1472	1038
Key alone - - - - -	- -	46
Lever or jack - - - -	93	108
Hammer, butt, tail, and head - -	108	108
Damper with spring - - -	186	
	1859	1300
Erard's intermediate lever, with half jack, double spring, check, oblique lever, damper, and hook - - - -	- -	341
Total weight of matter put in motion by the finger of the player - - -	1859	1641

Thus it appears that the actual quantity of matter put in motion by the finger in the production of each note, is less in the Erard than in the common construction, in the ratio of 16 to 18, or 8 to 9.

If the motion imparted to the several moving parts were properly combined with their weights, the resistance due to the inertia would be found to be in a still less proportion in Erard's mechanism. Taking, however, the ratio of the weights as the exponent of the resistance due to inertia, we shall have the total resistance to the finger in Erard's key to that of the common key, in the ratio of

$$3 \times 8 : 5 \times 9 = 24 : 45;$$

that is, as 6 to $11\frac{1}{4}$.

After what has been explained in the preceding pages, it will not be difficult to perceive why this comparative weight of touch is an inevitable condition attached to the common key. To be enabled to reproduce the note, that key must rise through its full play; and to effect this, with the promptitude necessary, in pieces requiring rapid execution, the reaction of the hammer and damper are altogether insufficient. The nature of the escapement is such, that the hammer, in its descent, does not react upon the jack in any sensible degree, and there is no force to bring up the key, except that of the damper. The constructor is, therefore, compelled to load the finger with the preponderance already mentioned, amounting, in the case of the key in the fourth octave, on which the experiment above stated was made, to more than half an ounce, in order to bring up the key with the necessary promptitude.

In the Erard key, the unlimited power of repetition which it possesses, renders it unnecessary that it should rise through its full play in order to reproduce the note, and therefore the same prompt action in rising is not needed; and it is even found that the reaction of the hammer and damper are more than sufficient, so that the constructor, instead of being compelled to load the finger with an additional weight necessary to bring up the key, is actually enabled to throw a certain preponderance on the side of the finger, so as to lighten the touch. It is evident that the amount of this preponderance is altogether arbitrary, and that the maker can adapt it to the habits and feeling of the performer. Some artists prefer a heavier, others cannot give effect to their finger without a lighter touch. Chopin, for example, being naturally of a feeble organization, found even the touch of Erard's instruments, as adjusted for such players as Thalberg or Listz, too much for his delicate finger. That maker availed himself of

the peculiar qualities of his key mechanism, to lighten the touch to a still greater degree in an instrument adjusted specially for that illustrious and much lamented pianist, and produced a touch which would have been almost sensitive to a feather.

These circumstances present examples of results of the invention of Sebastian Erard, which we alluded to as instances of the fertility of great mechanical inventions in precious consequences, perhaps unforeseen even by the inventors themselves.

The preceding results supply the data which are necessary to enable us to compare the expenditure of manual power, in the performance of the same piece, on a piano of the common construction, and on one of the Erard system. If T express the weight and inertia of the touch, and k the fall of the key in the common piano, and T' the weight and inertia of the touch, and k' the average play of the key in the piano on the Erard system, the labour necessary for the performance of the same piece on the two instruments will be as $T \times k$ is to $T' \times k'$.

But, according to what has been stated, we have

$$T : T' :: 11\tfrac{1}{4} : 6;$$

and if we assume, that while the full play must be allowed to the keys of the common piano, those of the Erard piano move on the average through only half their play, we shall have

$$k : k' :: 2 : 1.$$

It follows, therefore, that

$$T \times k : T' \times k' :: 22\tfrac{1}{2} : 6;$$

that is to say, the manual labour necessary to execute any piece of music on pianos of the common construction, is

greater than would be required on the Erard piano, in the ratio of $11\frac{1}{4}$ to 3, or very nearly 4 to 1.

There is no difficulty in computing from these data the actual amount of manual labour expended in the performance of any proposed piece of music on pianos of the one and the other system, and the result of such a computation is curious and interesting in more than one point of view.

It has been already shown, that the actual amount of manual labour expended in the performance of a piece of music is expressed by

$$P = n \times k \times T.$$

The weight of the touch T, varies in different parts of the scale; but on the pianos of the common construction, it may perhaps be taken at the average amount of 1200 grains, or the sixth of a pound very nearly. The fall of the key k, is five sixteenths of an inch, which is equivalent to the fortieth part of a foot.

In an elaborate piece, such as that of Thalberg, already mentioned, on the theme from the opera of Moses, there are about 10,000 notes put down by the fingers. For such a piece we shall therefore have

$$P = \frac{1}{6} \times \frac{1}{40} \times 10{,}000 = 41{\cdot}66 \text{ lbs.}$$

Allowing an equal amount of force as representing the inertia, it will follow that the performance of this piece on a piano of the common construction, exacts as much labour from the executant as would suffice to raise nearly 84 lbs. one foot.

The labour necessary to execute the same piece on the Erard piano, would be that which would suffice to raise $22\frac{1}{2}$ lbs. one foot.

These inferences will be less startling when it is consi-

dered how often as many as six or eight keys are put down together, and that when six are put down, the force exerted by the fingers is equal to that which would support a pound weight.

It will be evident that the conditions which have been explained above as affecting the weight of touch in the Erard pianos, gives the maker a great latitude in the adjustment of the keys, so as to adapt the instrument to the demands of different performers. It is found, practically, that the fingers which demand even the lightest touch, still require the weight of touch to be not less than about $1\frac{1}{2}$ oz. But for performers who prefer a greater weight of touch, it is only necessary to diminish the preponderance in favour of the finger, or even to throw a certain weight against the finger.

The patent under the protection of which the pianos of Erard were manufactured, having proved unproductive at the epoch when it expired (1835), owing partly to the great expense involved in the first establishment of a manufacture so novel, partly to the difficulty of making known to the profession and to the public the merits of the improvements, and partly to the systematic and persevering opposition of the manufacturers, and of those performers over whom they exercised a paramount influence, and almost a moral control *, an application was made to the Privy Council for an extension of the patent for seven years. On this occasion the Privy Council called in the aid of several of the most

* As an example of the influence that old houses exercised over professional men, it may be mentioned that as late as 1826, *i. e.* two years after the production of the first instrument of their construction, a distinguished pianist was prevented from making his appearance at one of the Philharmonic Concerts, because he had chosen one of Erard's pianos, and refused to play upon one of the old construction, as unfitted for his light and brilliant style of execution and music.

eminent pianists of the day, whom they consulted as to the qualities of the instrument, and several men eminent in science, whom they consulted as to the principles of mechanics applied in its construction. The result of the inquiry was a decision to grant an extension of the patent for seven years; and in order to guard against the decision being drawn into a precedent, it was expressly declared by Lord Lyndhurst, who delivered the judgment, that "in all such cases the Privy Council would require a strong case of hardship to be established, as well as the strongest proof of the utility of the invention, the extension of the patent of which is prayed for."

While the improvements in the mechanism of the touch, which we have here explained, have been in progress, others have been effected, individually less important, and demanding less refined efforts of invention, but which collectively have augmented the power, improved the tone, and increased the durability of the piano, rendering it at the same time more retentive of pitch and tune, and more capable of withstanding the deteriorating influences of climate and vicissitudes of temperature. These improvements, which chiefly affect the framing, bracing, and stringing, have not, however, like the touch, presented any difficulties which might not be easily surmounted by the ordinary resources of engineering skill, and the practical experience of manufacturers. The merits of these, such as they are, must be shared between the several great manufacturing establishments of Erard, Wornum, Stodart, Broadwood, Clementi (now Collard), &c. &c. Without going into the details of these secondary improvements of structure, or re-opening the discussion as to the claims of each of the leading manufacturers, or those in their employment, for their invention, we shall here notice briefly the most important of them.

In the first piano-fortes, the strings were hooked at one end by loops upon metal pins, planted in a bed of timber fixed in the framing. At the other end, they were rolled round steel pegs, called *wrest-pins*, which were also planted in a bed of timber connected with the framing. These two beds of timber were therefore drawn towards each other by the aggregate force arising from the tension of the entire system of strings.

The first step in the improvement of this system, consisted in the substitution of a metallic plate for the bed of timber in which the pins were planted, upon which the loops of wire at one end were hooked. The next was to place steel bracing bars over and parallel to the strings, so as more effectually to re-act against the tension. These steel bars were so fixed as to resist the mutual approach of the metallic plate on which the strings were looped at one end, and the bed of timber in which the wrest-pins were planted at the other.

Another modification, patented in 1809 by Messrs. Erard, requires notice here, as it had an important influence on the purity of the tone, and has, since the expiration of the patent, been generally adopted by piano-forte makers. This consists in giving the strings an upward bearing by means of metallic studs planted near the wrest-pins. One of these is represented at *z*, *fig.* 3. Previously, the strings were supported on a sort of bridge placed under them near the wrest-pins.

The next step in the improvement of the framing, was the substitution of a metallic bar for the bed of timber containing the wrest-pins of the two upper octaves.

In fine, in 1850, a patent was taken out by M. Erard, for a complete system of metallic framing for the strings, the entire bed of timber supporting the wrest-pins being replaced by a wrest-plank of metal, and the wrest-pins themselves being superseded by a combination of screws and nuts.

The end of the string is attached to a movable nut, or female screw, in which a fixed male screw works, this latter being attached to the metallic plate of the framing. The tuning key being applied to turn the fixed male screw, the nut is moved in the one direction or the other upon it, the string accordingly tightened or relaxed, and the pitch of the note raised or lowered.

The magnitude of the instrument, the extent of its scale, the length, thickness, and number of the strings, and the dimensions of the vibratory part called the sounding-board, have severally undergone a considerable increase, so that the extra-sized grand piano-fortes, several of which were exhibited in the Crystal Palace, bear to the pianos which existed half a century ago, nearly the same relation as the organ in Exeter Hall bears to the instrument used by an itinerant musician.

In the extra grand horizontal pianos, exhibited by M. Erard, an improvement of stringing was observed which merits notice.

Hitherto each note of the lowest octaves of the bass in the horizontal grand piano-forte has been produced by the action of the hammer upon two strings. It was found that in strings of such length, there was a constant liability of their striking each other, and jarring during their vibration, and this injured the effect of their tone. This defect is removed in the improved instrument by making each hammer of the lowest octave act upon a single string, whose thickness is increased as well as its length. By this expedient, the jar which prevailed previously is effectually prevented, and force and fulness of tone are obtained, which exceed in a striking degree the effect of the instruments of the old construction.

Another improvement presented by the same makers, which will prove a great convenience and advantage to organists, is the addition of pedals to the grand piano-forte correspond-

ing with the pedals of the organ. By these means the performer plays with both hands and feet, exactly as in the case of an organ. All organ music, and the music of the ancient composers, such as Sebastian Bach, the new compositions of Mendelssohn, Schœmann, Lefebvre-Wely, Lemmens, and other modern masters, can be performed and practised on such an instrument. The effect is very remarkable, the notes produced by the feet having a power and quality totally different from those which the same notes would have, if played by a second pair of hands upon the same instrument.

XV.

THE WORKSHOP OF M. FROMENT.

The visitor to the great Exhibition, in turning over the leaves of the Official Catalogue, would probably pass without notice an item, No. 1609., in the French Department, consisting of three lines, as follows: —

"Gustave Froment — 5 *rue Ménilmontant, Paris.*

"Scientific Instruments. Theodolite; and various models of electro-motive power."

Assuredly brevity could no further go. Never was presented a more conspicuous example of modest reserve on the part of artistic genius the most exalted. No effort seems to have been thought of by the exhibitor even to call the attention of the commentators of the catalogue to the claims of these productions of the highest scientific art; for, while comment and panegyric have been liberally, not to say profusely, accorded to exhibitors, who, whatever may have been their merits, presented claims immeasurably below him whose illustrious labours we are about to notice, not a single word of comment drew the attention of the general public to objects, the fabrication of which would have presented the highest attractions, even to the most idle and incurious of the loungers of the Crystal Palace.

Happily for the cause of science and art, and for that of

justice, the same neglect did not prevail among the eminent persons to whom the distribution of honours was entrusted. They discerned and appreciated the titles of M. Froment, and most justly accorded him, by an unanimous vote, a council medal. The authorities of his own country added to this the decoration of the Legion of Honour.

If M. Froment were as ambitious of personal *éclat* as of the attainment of perfection in his workmanship, he would have transported to the Crystal Palace a part of the beautiful machinery of his Parisian workshop, and would have exhibited, not his theodolite alone, but the process of its fabrication. Had he done this (and he might have accomplished it without difficulty), his station in the great Exhibition as an object of attraction would have rivalled even the Koh-i-noor.

The inventions and improvements of M. Froment, in the construction of instruments of precision, and of scientific apparatus generally, can nowhere be so advantageously seen and appreciated as in his own workshop in Paris. There may be seen not only the finished instruments and machines, but their practical application *in the construction of each other!* There may be seen electro-magnetism applied on a large scale, as a permanent and regular moving power, in the fabrication of mathematical and optical instruments.

The electro-motive machines of M. Froment, which are very various in form, magnitude, and power, derive, nevertheless, their motive force from one common principle, which is the same that has been applied in certain forms of electro-magnetic telegraph.

An electro-magnet and its armature are placed so that when the electric current is suspended they will rest at a certain distance asunder, and when the current is established they will be drawn into contact by their mutual attraction. When

the current is again suspended they will separate. In this manner, by alternately suspending and transmitting the current on the wire which is coiled round the electro-magnet, the magnet and its armature receive an alternate motion to and from each other, similar to that of the piston of a steam-engine, or the foot of a person who works the treddle of a lathe. This alternate motion is made to produce one of continued rotation by the same mechanical expedients as are used in the application of any other moving power.

The force with which the electro-magnet and its armature attract each other, determines the power of the electro-motive machine, just as the pressure of steam on the piston determines the power of a steam-engine. This force depends on the nature and magnitude of the galvanic pile which is employed.

The pile used by M. Froment for the lighter sort of work, such as that of driving his engines for dividing the limbs of astronomical and surveying instruments, and microscopic scales, is that of Daniel, consisting of about 24 pairs. Simple arrangements are made by means of commutators, reometers, and reotropes, for modifying the current indefinitely in quantity, intensity, and direction. By merely turning an index or lever in one direction or another, any desired number of pairs may be brought into operation, so that a battery of greater or less intensity may be instantly made to act, subject to the major limit of the number of pairs provided. By another adjustment, the copper elements of two or more pairs, and at the same time their zinc elements, may be thrown into connection, and thus the whole pile, or any portion of it, may be made to act as a single pair, of enlarged surface. By another adjustment, the direction of the current can be reversed at pleasure. Other adjustments, equally simple and effective, are provided, by which the current can

be turned on any particular machine, or directed into any room in which it may be required.

The pile used for heavier work, is a modification of Bunsen's charcoal battery, in which dilute sulphuric acid is used in the porous porcelain cell containing the charcoal, as well as in the cell containing the zinc. By this expedient the noxious fumes of the nitric acid are removed, and although the strength of the battery is diminished, sufficient power remains for the purposes to which it is applied.

The forms of electro-motive machines constructed by M. Froment are very various. In some the magnet is fixed and the armature movable; in some both are movable.

In some there is a single magnet and a single armature. The power is in this case intermittent, like that of a single acting steam-engine, or of the foot in working the treddle of a lathe, and the continuance of the action is maintained in the same manner by the inertia of a fly-wheel.

In other cases two electro-magnets and two armatures are combined, and the current is so regulated, that it is established on each during the intervals of its suspension on the other. This machine is analogous in its operation to the double-acting steam-engine, the operation of the power being continuous. The force of these machines may be augmented indefinitely, by combining the action of two or more pairs of magnets.

Another variety of the application of this moving principle, presents an analogy to the rotatory steam-engine. Electro-magnets are fixed at equal distances round a wheel, to the circumference of which the armatures are attached at corresponding intervals. In this case the intervals of action and intermission of the currents are so regulated, that the magnets attract the armatures obliquely as the latter approach them, the current,

and consequently the attraction, being suspended the moment contact takes place. The effect of this is, that all the magnets exercise forces which tend to turn the wheel on which the armatures are fixed constantly in the same direction, and the force with which it is turned is equal to the sum of the forces of all the electro-magnets which act simultaneously.

This rotatory electro-motive machine is infinitely varied, not only in its magnitude and proportions, but in its form. Thus in some the axle is horizontal, and the wheel revolves in a vertical plane; in others the axle is vertical, and the wheel revolves in an horizontal plane. In some the electro-magnets are fixed, and the armatures movable with the wheel; in others both are movable. In some the axle of the wheel which carries the armatures is itself movable, being fixed upon a crank or excentric. In this case the wheel revolves within another, whose diameter exceeds its own by twice the length of the crank, and within this circle it has an hypocycloidal motion.

Each of these varieties of the application of this power, as yet novel in the practical operations of the engineer and manufacturer, possesses peculiar advantages or convenience, which render it more eligible for special purposes.

Of all the purposes to which this moving power is applied in the workshop of M. Froment, the most beautiful is that of making the divisions on the limbs and scales of astronomical and geodesical instruments, and of instruments of precision in general. The machines by which such divisions are engraved are automatic, each receiving its motion from an electro-motive machine of proportionate power and magnitude.

The limb to be divided is fixed upon an horizontal table, which receives a slow and intermitting progressive motion from a fine screw. This screw itself is urged at intervals by

a ratchet wheel. The catch or click by which this ratchet wheel is driven, can be so adjusted as to take one, two, or several teeth at each stroke, and therefore to move the table carrying the limb through a greater or less space, according to the magnitude of the divisions to be engraved upon the scale. Over the limb to be engraved is placed the point or edge by which the incision is produced, which is either hardened steel or diamond. During the progressive motion of the table carrying the limb, this cutter is elevated, so as not to touch it. In the intervals during which the motion of the table is suspended, the cutter descends upon the limb, and, being pressed upon it with sufficient force, is drawn upon it in a direction at right angles to the motion of the table, thus engraving upon it the line which marks the division. Thus the motions of the limb and the cutter are alternate, each being in action while the other is at rest. The cutter is fixed upon an arbor which derives its motion from the same crank which works the ratchet, but its connection is arranged so as to give them the alternate action just mentioned.

By an arrangement provided in this arbor, a more extended motion is imparted to the cutter at every tenth stroke of the ratchet, the effect of which is, that every tenth division made upon the limb by the cutter is distinguished by a longer line than the intermediate divisions.

In some cases both the motions above described are imparted to the cutter, the limb upon which the divisions are engraved being kept at rest. The cutter is, in that case, alternately impressed with two motions, one which transfers it from division to division while it is raised from the limb, and the other in a direction at right angles to this, while it is pressed upon the limb, and makes the incision which marks the division.

These dividing instruments vary in form and magnitude according to the purposes to which they are applied.

Those which are used for engraving the divisions on the circular limbs of theodolites and other instruments of the larger class, consist of a circular metallic table of solid construction and suitable magnitude, to which a motion round its centre in its own plane is imparted by means of a finely-constructed worm, which works in teeth formed on the edge of the circular table itself. Means are provided by which the circular limb to be divided can be fixed upon this table, so as to be exactly concentric with it, and to be moved with it. The cutter is fixed so as to slide upon a rod which is extended over this table and parallel to it. The cutter can, by this arrangement, be adjusted at any required distance from the centre of the table, so as to correspond to a circular limb of any magnitude not exceeding that of the table.

In the process of engraving the divisions, the worm and the cutter are moved alternately by self-acting mechanism, deriving its motion from the electro-motive machine by which all the apparatus of the workshop is driven. The worm is so adjusted, that by each action on the table, the limb to be engraved is moved under the cutter (which is then elevated so as not to act upon it), through a space equal to the interval between the divisions. The worm then stops, and the limb being at rest, the cutter descends upon it, and is drawn through a space equal to the length of the line to be engraved, and the division is accordingly marked upon the limb. The cutter is then again elevated, and the limb again moved under it by the worm, and so on.

In this case the divisions which mark degrees are distinguished from the intermediate minutes by larger lines, mechanical arrangements being provided in the wheelwork by which the motion of the cutter is thus affected.

In the apparatus for engraving straight scales and standard measures of the larger sort, the scale to be divided is fixed, and both motions above described are given to the cutter. In this case the cutter is fixed upon a frame which is moved by a fine screw, parallel to the scale to be divided. The revolution of this screw moves the cutter from division to division, and in the intervals during which the screw is at rest the cutter receives the other motion by which the division is engraved.

The more finely-divided scales, used for microscopic purposes, are made on glass, with a diamond point. The principle and form of the mechanism by which this is accomplished, is the same as that used for the division of larger scales; but in this case the scale to be engraved is moved under the cutter from division to division, the cutter being only moved while making the incision.

By means of this beautiful mechanism, scales are engraved on the surface of glass, the divisions of which are separated by an interval so minute as the 25,000th part of an inch.

There are various expedients by which these may be applied to the measurement of the dimensions of microscopic objects. Thus, two points or lines placed in the field of view of the microscope, may be movable by means of adjusting screws. The object to be measured being placed in the field, the observer adjusts these points or lines so that they shall coincide with the extremities of the image of the object to be measured. The object is then removed, and the divided scale is substituted for it. The observer adjusts the position of the scale, so that it shall be between the two lines or points which marked the extremities of the object. The zero of the scale being brought to coincide with one point, the number of the division which coincides with the other point will determine the length of the object.

All these machines are self-acting. The limb or scale to be divided being once placed on the table of the dividing engine, no further interference of the human hand is needed. The machine of itself begins its work at an appointed hour, minute, and second, and when the last division of the scale has been engraved, it not only suspends its own action, but stops that of the electro-magnetic machine by which it is impelled. These automatic arrangements must not be regarded as mere mechanical superfluities, upon which the boundless fertility of invention which characterises the genius of M. Froment has been lavished; they are of great practical value and importance. It happens, for example, that in these delicate operations, the tremor of the ground on which the workshop stands, produced by the movement of vehicles of transport in the adjoining streets, affects in a sensible degree the motion of the cutting point. It is therefore always preferable to execute the most delicate work in the dead of the night. Now, by the automatic contrivances above mentioned, this can be accomplished withou imposing on the superintendent the necessity of watching. A clock, provided with an apparatus similar in principle to a common alarum, is put in mechanical connection with the dividing machine, and is set so as to start the machine at any desired hour. This being done, and the limb to be divided being fixed upon the table under the cutter, the apparatus may be left to itself; the superintendent may retire to rest, and, at the hour of the night which has been selected, the electro-motive machine will be started by the clock, and the dividing engine will commence, continue, and complete its work with the most admirable certainty and precision, and, when completed, the electro-motive machine will be stopped, and all reduced to rest.

The magnitude of the dividing engine for microscopic

scales, is about 8 inches long by 6 inches wide, and 4 inches high. The magnitude of the electro-motive engine necessary to drive it, is not more than 4 inches square in its base, and 3 inches high.

It is scarcely necessary to observe, that the more minute class of these scales can only be seen by the aid of a microscope of high magnifying power. This will be easily understood when it is considered that, in a space measuring a tenth of an inch in length, there are, in the more minute scales, 2500 divisions. Such is, nevertheless, the precision of the execution, that, when looked at with a sufficiently high magnifying power, the lines exhibit the most perfect evenness and regularity.

Among the numerous inventions of M. Froment, the results of which were shown at the Great Exhibition, is his method of writing and engraving in characters of microscopic minuteness. As the method by which these marvellous effects are produced is not yet patented or made public, we are not at liberty to explain its details; but it may be stated generally to consist of a mechanism by which the point of the graver or style is guided by a system of levers, which are capable of imparting to it three motions in right lines which are reciprocally perpendicular, two of them being parallel, and the third at right angles to the surface on which the characters or design are written or engraved. The combination of the motions in the direction of the axes parallel to the surface on which the characters are engraved or written, determines the form of the characters, and the motion in the direction of the axis at right angles to that surface determines the depth of the incision, if it be engraving, or the thickness of the stroke, if it be writing.

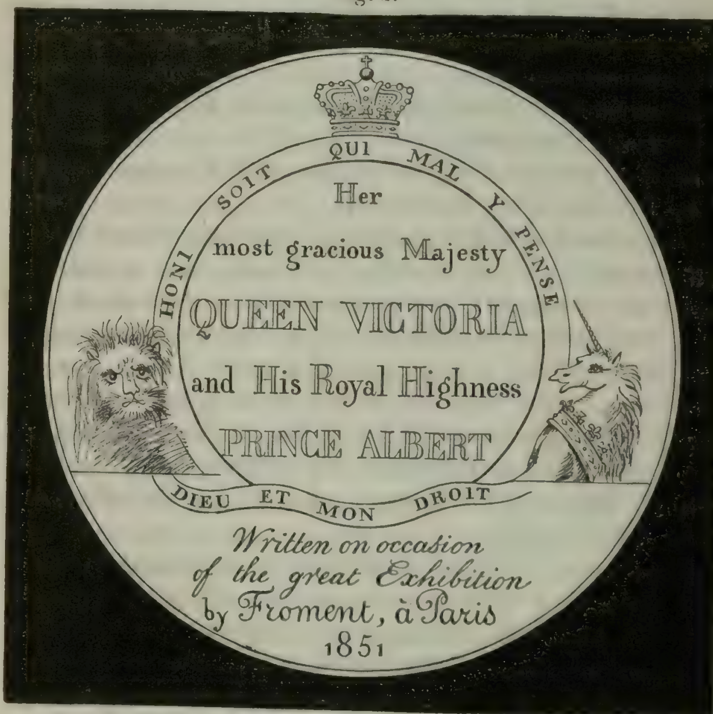
The astonishing minuteness and precision with which designs and characters may be engraved by this invention, may

be judged from the annexed engraving, in which *fig*. 1. represents a circular surface of glass the 30th of an inch in diameter, within which the design and characters represented in *fig*. 2. were engraved, to be presented to H. R. H. Prince Albert. The design is represented in *fig*. 2. as it appears in

Fig. 1.

REAL MAGNITUDE.

Fig. 2.



APPEARANCE AS SEEN IN THE FIELD OF THE MICROSCOPE, THE OUTER CIRCLE BEING ONLY $\frac{1}{30}$TH OF AN INCH IN DIAMETER.

the field of a microscope which magnifies the linear dimensions 150 times.

The celerity with which the apparatus can execute its work may be judged from the fact that M. Froment wrote for us, in less than five minutes, within a circle the 40th of an inch in diameter, the following words, with sufficient accuracy to bear being viewed with a high magnifying power: —

Written
as a microscopic object
for Dr. Lardner,
by Froment, at Paris,
1852.

Among the numerous inventions of M. Froment are two electro-magnetic telegraphs, one which transmits visible signs, and another which writes the despatch at the distant station to which it is transmitted.

The form of the first is that of a small piano-forte of four octaves, having however only white keys. On each key is engraved a letter, so that the entire range of keys are marked with the letters of the alphabet. The keys which are marked with the first ten letters, are also marked with the ten numerals. Upon the case of this little piano is placed a small box like a clock, having a dial in front, the circle of which is marked by the letters of the alphabet corresponding to those engraved on the keys. A hand like that of a clock is fixed on this dial.

When the instrument is prepared for operation, the hand points to the division of the dial which corresponds with 12 on a common clock. If any key be depressed by the finger, the hand moves round the dial in the same direction as the hand of a clock, and stops at the letter on the dial which corresponds with that upon the key which has been depressed. If the key be then allowed to rise, and any other key be depressed, the hand will again begin to move in the

same direction, and will again stop when it arrives at the letter marked upon the key. In this way any series of letters may be indicated by the hand upon the dial.

An apparatus of this description being placed at one telegraphic station, another precisely similar to it is placed at any other station with which it is desired to establish a telegraphic communication. The instruments being connected by the conducting wire which extends from station to station, the hands upon the two dials will be moved in exact accordance, always pointing at the same time to the same letter. Thus, if we suppose that the key A upon the instrument at London is put down by the finger, the hands on both the dials at London and Edinburgh moving together, will stop together when they point to A on the two dials. If the operator at London then transfer his finger to any other key, F for example, the hands on both dials will move successively over the divisions marked B, C, D, E, and will stop at F; and in the same manner any succession of letters may be indicated on the dial at Edinburgh by putting down in succession the corresponding keys on the instrument in London.

When it is desired to remit an answer to London, it may be done in like manner by putting down in succession the corresponding keys on the instrument at Edinburgh.

An agent at the place to which the despatch is transmitted, observes the succession of letters indicated by the hand upon the dial, and commits them to writing.

To understand the manner in which these effects are produced, let it be conceived, that in the box of the piano, behind and parallel to the keys, there is fixed a steel cylindrical axle, the length of which corresponds with the range of keys, and the diameter of which is about a quarter of an inch. At one extremity of this axle is fixed a wheel, having

as many teeth as there are keys upon the instrument. At the other extremity is fixed a ratchet wheel with the same number of teeth. When the catch rests in the teeth of this wheel, the axle cannot turn; but when it is removed, as it may be by putting down any key of the instrument, the axle is free to revolve.

The ratchet wheel is placed in connection with clockwork, by which a motion of revolution is imparted to it and to the axle upon which it is fixed, whenever the catch is raised from the teeth of the ratchet wheel. The toothed wheel fixed upon the other end of the axle, partakes of this motion, and it is so connected with the conducting wire which is carried from station to station along the telegraphic line, that the current is interrupted as each tooth of the wheel passes. The number of alternate transmissions and suspensions of the electric current passing from station to station, will therefore be always the same as the number of teeth of the wheel attached to the axle which passes behind and parallel to the keys.

The conducting wire upon which this intermitting current is transmitted, passes at each telegraphic station through an electro-magnetic machine like those already described, and necessarily produces a stroke of the armature on the magnet for every alternation of the current, and, therefore, for every tooth which passes under the ratchet at the station from which the despatch is transmitted. The oscillations of this electro-magnet are made to act upon the hand placed upon the dial already described, so that this hand shall move over one of the divisions which separate letter from letter on the dial for each stroke of the magnet.

The same electric current whose intermitting action thus moves the hand on the dial at any one station, moves it equally at all other stations, so that the hands of all the

dials at all the stations always advance simultaneously through the same number of divisions, and, consequently, if they are once set so as to point to the same letters, they must continue always to direct themselves to the same letters, whatever be the motions imparted to them by the current.

It has been seen, however, that the motion imparted to the hand on the dial by putting down the key, is always arrested when the hand arrives at the letter marked upon the key. It remains, therefore, to explain how this effect is produced.

Attached to the remote end of the key lever is an arm placed nearly at right angles to it, which is raised so as to approach the axle when the key is put down by the finger. Attached to the revolving axle, and likewise at right angles to it, at a point immediately over the key, is a projecting arm which revolves with the axle. This arm is so placed upon the axle that it encounters and is stopped by the arm put forward by the key lever at the moment when the hand on the dial points to the letter inscribed on the key, and the same effect is produced by the same means on the dials at all the stations.

Thus it appears that the depression of the key both starts and stops the mechanism. It starts it by raising the catch from the ratchet wheel. It stops it by throwing the arm projecting from the key lever in the way of the arm projecting from the axle, which is in the meanwhile kept in revolution.

By starting the axle, the hands upon the dials at all the stations are made to move round the dials in the direction of the order of the letters, commencing from the last letter to which the hand was directed. By stopping the axle, the hands on all the dials are arrested when they arrive at the letter inscribed upon the key.

It is evident that the celerity of communication by this telegraph is limited by the interval necessary for the hand on the dial to move from one letter to another, and as that interval is subject to all lengths, from one division to an entire circumference, it follows that the average interval between the transmission of the successive letters or signs, is the time necessary for the hand to move over half the circumference of the dial. This interval will vary more or less with the strength of the current, and the consequent rapidity of the successive strokes of the electro-motive machine.

In the other form of telegraph contrived by M. Froment, the despatch is written on the surface of a cylinder covered with paper, by a process bearing some analogy to the telegraph of Morse already described. The pencil is pressed continually on the paper, which is moved under it by a rotatory motion imparted to the cylinder. When the electro-magnet does not act upon the pencil, a straight line is traced upon the paper. But when the magnet acts, the pencil receives an oscillating motion parallel to the paper, which, combined with the motion of the paper, causes it to produce a zigzag line. The alternate transmission and suspension of the current, therefore, cause the pencil to trace a line on the paper which is alternately straight and zigzag, the lengths of the straight and zigzag parts being varied according to the lengths of the intervals during which the current is transmitted and suspended. The letters or other signs are expressed by various combinations of straight and zigzag lines, as in the systems of Morse and Bain.

When the cylinder covered with paper has made one complete revolution, the inscribing pencil would return upon its path, and the next line would be written upon, and therefore confused with, the last written. This is prevented by fixing the cylinder upon a screw, the width of whose thread

is equal to the distance between line and line on the paper. By this means the pencil traces an helical curve upon the paper, each successive convolution being separated from the preceding by a space equal to the distance between the threads of the screw upon which the cylinder turns.

In the workshop of M. Froment a multitude of other ingenious applications of the electro-magnetic phenomenon are exhibited, which our limits do not permit us to describe. Those who, in visiting the French metropolis, are so fortunate as to obtain permission to inspect this beautiful collection of machinery, will find in it an object far more deserving of attention than many of the *sights* to which travellers are usually conducted.

No one in the least degree conversant with physical researches can enter the precincts of this beautiful *atelier* without feeling that the very atmosphere with which he is surrounded is pregnant with the genuine spirit of practical science.

PART II.

REVIEWS AND ESSAYS.

BY THE

BARON C. DUPIN, M. C. CHEVALIER, M. J. LEMOINNE,
AND M. HECTOR BERLIOZ.

COMPARISON OF THE INDUSTRY OF PARIS AND LONDON,

BY THE

BARON CHARLES DUPIN*,

MEMBER OF THE NATIONAL INSTITUTE OF FRANCE.

In the spring of 1850, when France had scarcely escaped from fearful troubles, and when capital again began to be employed in the arts and manufactures, England, which for fifty years had regarded our industrial exhibitions as the playthings of a vain and frivolous people, considered the moment propitious herself to adopt a measure which she affected to ridicule in another. She resolved to collect together for a vast exhibition, not only the products of her own national industry, but those of the whole world.

It could not be supposed that such a project would at once meet with the acquiescence of all other nations. It was, on the contrary, regarded elsewhere with distrust and suspicion, and other countries turned their view toward France, to observe what decision she would take in a question of such international interest.

In France, at first, opinion was not unanimous. To some

* This essay is extracted from the introductory lecture delivered by M. Dupin, at the Conservatoire des Arts et Métiers, on the 4th January, 1852.

it appeared that England, invading our ground, wrested from us our national glory, as she took our colonies when we had rendered them productive. It appeared to us, that after half a century of French exhibitions, imitated by Spain, the Low Countries, Prussia, Bavaria, Austria, and Russia, it was for us to take the initiative. The idea originated with us in 1845, and would have been carried out in 1849, but for the prostration of the industrial establishments. But were we then in a position to enter the lists against Great Britain, which, for 160 years had not seen her internal tranquillity disturbed, guaranteed as she was by the ocean against foreign invasion, and even against the contamination resulting from continental theories?

This was a position, certainly, at which the prudent might hesitate, but from which the courageous would not retreat, renouncing the honour of the combat. France, regardless of her still bleeding wounds, announced that she accepted the challenge, and the other states were not slow to imitate her.

Behold us, then, inviting those of our fellow citizens, who, in their respective pursuits, had enlarged the frontiers of industry; urging them to competition, and demanding their products such as they existed, without charlatanism, without extraordinary effort, and without creating *chefs-d'œuvre* for the occasion.

Alas! at other periods these works would have been much more numerous and splendid. We were first obliged to omit all who, during three years of vascillating credit, by turns beaten down and crushed, and then again half restored to commercial existence, had at length yielded to the force of circumstances, and had been erased from the lists of industry. We had also to omit those who, though still holding their ground, were so nearly exhausted, that any new sacrifice, such

as preparing products for an exhibition in a foreign country, was beyond their means. I knew some amongst this latter class, who in the Exhibition of 1844, and again in that of 1849, obtained the gold medal and the decoration of the Legion of Honour, but who could not, reduced as they were in 1851, dispute the palm which they doubtless would have obtained, if they had exhibited the exquisite products of their highly advanced industry.

Thus we, who reckoned 5000 manufacturers at our late exhibition, could not present at London more than 1747; while the United Kingdom, with its numerous and flourishing colonies, had 9000, favoured as they were by a commerce mounting to 160,000,000*l.* per annum.

To receive the products of 18,000 exhibitors of all nations, the famous Crystal Palace, of which I must give you some idea, was erected. Imagine, then, that in the main alley of the Tuileries, so far as the basin of the largest fountain, a palace of iron and glass were built three times as wide as the vast avenue which forms so noble a feature in the garden of Lenôtre. Such was its area. Shall I now give you an idea of its height? The English Government, with fanatic reverence for the secular trees of their largest metropolitan park, made it a condition that they should not be destroyed. The architect, a gardener, regarded them as green-house plants! Above their heads he placed his crystal dome, and when you entered the cross nave you were led to exclaim, "Why these are not merely very large shrubs placed in due proportion beside the products of all the arts; they are the colossi of vegetation, similar to the Rosnis, planted in our forests and before our churches two centuries and a half ago, by the glorious minister of Henry IV!"

As the English formed more than the half of the exhibitors, they took to themselves more than half the space.

This was fair. As we were less in number, — I say less in number with reference to the wealth of France, — our space was disputed, and perhaps a little too much. But by this very means there was conferred on us the same service that the rigid measure of the verse confers on poetry. By confining to such a degree the space set apart for us, the impression of our *chefs-d'œuvre* on the imagination of the spectators was rendered more powerful.

The difficulties of arrangement were delicate and numerous; the zeal and intelligence of the French *commissariat*, ably directed by M. Sallandrouze de la Mornaix, happily surmounted them.

I shall begin by rendering sincere homage to the grandeur, I would almost say the majesty, of the English Exhibition. Nothing could display under a more vast and complete aspect, the resources of genius, and the prodigies of labour, which are the characteristics of that mighty empire.

The half of the Crystal Palace not being sufficient for England, the space in one of the wings was augmented by a lateral gallery of enormous width. It was there that, if I may use the term, the productive power of Great Britain was made to breathe and labour: its steam-engines, its hydraulic engines, its large machines for carding, spinning, and weaving, which produce 200,000,000*l.* sterling; and many other machines lately brought to perfection in that country.

Still this gallery did not contain the apparatus, so powerful and so various, of the railways, — rails, locomotives, tenders, and waggons,—nor carriages of all descriptions, from the most cumbrous cart to the most elegant cabriolet, or the most sumptuous state carriage.

Neither did this gallery include the agricultural implements, so numerous, so perfect, but so costly in England. In this country they have already attempted ploughing by steam!

But by superseding the labour, the country is depopulated and filled with machines. I leave it to statesmen to decide whether the unlimited emigration which must ensue, will also be part of the national progress.

I should abuse your patience if I took you from point to point, to recount all that England exhibited of her opulent, useful, ingenious, and various industries. It is enough that I endeavour to give you a just idea of her productive power.

Let us now turn to other nations, and especially to France. When we entered the Crystal Palace by the cross southern nave, and arrived at the centre of the building, the products of the United Kingdom were seen on the left, and those of the rest of the world on the right. The immense cross formed by these two naves, had the general form and majestic aspect of a cathedral six times as large as Notre-Dame de Paris.

By the side of the foreign nations, as if to impose on every one by its excess of wealth, a company of English merchants, who hold in the East under their sway a hundred and thirty millions of people, — His Majesty the East India Company, — have sought amongst their treasures some object of great value. They discovered the Koh-y-noor, a diamond the name of which signifies the *Mountain of Light*, and the price of which is estimated by connoisseurs at two millions sterling. A value so fabulous, of an article of no extraordinary appearance, rendered this an object of perpetual attention to the multitude.

France also had its crowds of spectators like the Koh-y-noor. The first object that caught the view, after leaving the monster diamond, was the glass-case of M. Lemonnier. It contained a regal ornament formed of precious stones and diamonds, the largest exceeding the size of a bean, and the smallest diminishing in proportions full of elegance,

and forming bunches of electric sparks, finished by those infinitely small stones called by artists diamond dust. Tiara, necklace, bracelets, mounted in flowers and bouquets, on stems so flexible that the lightest agitation caused by the steps of the visitors caused them to vibrate, emitting millions of sparks, and exhibiting rays of inexpressible splendour and beauty! — such is the value that French art can confer on the most precious of metals and gems.

At the other extremity of the same national section, another group of objects attracted admirers to a new subject of French magic. Rags and shreds of cloths, presenting thousands of colours, were converted into flowers that I really detract from when I call them artificial. It is not only in appearance, it is in their structure, and, I should almost say, in their physiology, that they are true to nature. There are whole plants in the grace of their vernal bloom, others ready to burst into flower under the influence of a summer sun, others with the sere leaf and varied tints of autumn,— a parterre, in truth, such as Milton dreamed of in his Paradise Lost. These were the *chefs-d'œuvre* of M. Constantin.

Time would fail if I were to point out all the crowds which were formed, and perpetually renewed, before the brilliant works of our exhibitors of the higher class, who certainly were not all, as the Erards, the Saxes, the Lemires, the Matifats, and the Ringuet-le-Prince, stationed on the privileged line of the principal nave. The others only caused more surprise and admiration when the spectator discovered them at the bottom of transversal alleys, in which were exhibited the greater number of the wonders of the special industry of Paris.

Such was, for instance, the stall of M. Froment Meurice, where so many splendid tributes, ordered to acknowledge

public gratitude, surrounded the principal object which was especially entitled to the medal. This object was composed of four goddesses surmounting a celestial globe, supported by four Tritons. This great work was an evidence to what degree of excellence we have arrived in the art *de repousser l'argent*, to approach the perfection of sculpture.

Such was, on the other hand, in a nook, which served as a peristyle to our veritable *Musée des beaux arts industriels*, a statue that Pradier — our Praxiteles — modestly called Phryneas, although it possessed the beauty of a Venus. She revealed to us the sacred fire that the chisel of genius can create, glowing within the confines of a vivified marble. The great Jury of all nations, in accordance with the enthusiastic public, has assigned to this work a pre-eminent place among the *chefs-d'œuvre* of sculpture presented at the great Exhibition. I would desire that the statue to which France owes so much honour were placed in our National Museum, with an inscription stating our artistic victory.

But let us now resume the consideration of industrial products, properly speaking, limiting our comparisons to the objects exhibited by Paris and London.

We must first place in its true light the relative disadvantage in which stood our metropolis.

To this end, the extreme difficulties under which Parisian industry suffered before it was exposed to a competition with British industry, must be mentioned.

The year 1847, in which the price of wheat was doubled, could not certainly be mentioned as a very happy epoch for the people. Yet the Municipal Council of Paris paid for the working classes all the excess of price of 1847 above the average price of bread in 1846. By this means the suffering was reduced to supportable limits. The population was tranquil, work was abundant, the exports from Paris

amounted to 168,572,187 francs (6,742,888*l.*), and those from the whole of France to 719,750,178 francs (28,700,000*l.*).

In the eight weeks which preceded the convulsion of February, 1848, the prosperity of the operatives of Paris was so great, that out of their simple earnings, the expenses of the pleasures of the carnival being deducted, they placed 320,000*l.* in the savings banks. Yet it was on the pretext of their misery that arms were put in their hands; and eight days after this revolution it was found necessary to close this treasury of the working classes, for fear the privations of the whole people would oblige them to exhaust it with frightful rapidity.

But this was not all. To relieve the distress, which every moment was increasing, the *ateliers nationaux* were opened to 100,000 unemployed Parisian operatives. These *ateliers nationaux* it was, which became so celebrated by the incredible manner in which no work was done in them. They were a club of 100,000 idlers under arms, stimulated by perpetual orators.

About the same period was opened, at the Luxembourg, the states-general of bankrupt masters and workmen in revolt, who decreed a scale of wages, having three and four francs as a minimum for a day's labour reduced to ten hours. The heads of factories suffering on all sides, with orders rejected, and their profits reduced to nothing, gave themselves up to despair. They closed their shops; and the most indifferent workmen, they who voted themselves wages beyond their merits, did not receive a centime.

Four months more were scarcely passed, and the wages of idleness were paid, not only to 120,000, but 200,000 in July; and in August, 300,000, of every age and sex, were deprived of all means of subsisting by their labour. To prevent their dying of hunger, there was given them for their support—

what think you, by way of substitution for wages, to families who no longer could obtain them?—eighteen centimes ($1\frac{3}{4}d.$) per day and per head. Such was the supreme felicity reserved for the workmen in 1848!

If such were the situation of simple workmen, imagine what must have been the position of the heads of the workshops, the factories, and the houses of business! They were almost in the situation of terror exhibited a few months ago, when, if they had lodgers in their houses, and asked for their rents to pay their workmen, a black flag was suspended over the door, as in times of the plague, to designate a public pestilence. Credit was no more, because the capitalists, denounced as the sacrificers of the people, had immediately withdrawn what was then called *infame capital.* The heads of establishments could not find means to meet their expenses; the industrial creditor could not obtain, at the savings bank, the small deposit that he had secured by his foresight. Bankruptcy undeserved became so frequent, that a decree was made, relieving the unfortunate persons whom it reached from the penalties that, in happier times, the law would visit on them.

Since this time has appeared the magnificent work undertaken by the Chamber of Commerce of Paris, under the direction of M. Horace Say. This work, having reference to the industry of the capital, such as it was in 1847 and 1848, adds irresistible evidence to the facts I have cited.

In the city of Paris, in 1847, there were 64,816 heads of workshops or factories, who afforded employment to—

217,195 workmen of all ages,
120,742 workwomen of all ages,
19,114 apprentices.

This mass of workpeople, during the year of scarcity,

1847, had, under the direction of the 64,816 heads of workshops or factories in the Capital, fabricated a total quantity of products equal to the prodigious sum of —

	1,463,628,350 francs
In 1848 the result of labour has been ascertained, and was found to represent only a value of - - - - -	677,524,117
The absolute loss of 1848 compared with a year of scarcity, has therefore been for Paris alone - - - -	786,104,233 francs

Let us now calculate the loss of the wages sustained by the workpeople of Paris. In the great statistical inquiry of which I have spoken, the following is found to be the condition of that class in 1847: —

Workmen earning 3 francs a-day - -	27,453
From 3 to 5 francs a-day - - -	157,216
Above 5 francs, up to 35 francs a-day -	10,393
Total - - - -	195,062

It was also found that in Paris, out of 100 workpeople, 13 could not read or write. This proportion gives us the 195,062 adults, whose wages are above stated; 25,357 individuals who do not know how to read or write, and probably the greater number of them are comprised in the 27,453 individuals earning only three francs a-day. The surplus of the least paid know little more than those who are wholly ignorant.

The chief part of these ignorant persons come from the departments, or from abroad, and it depends on themselves to ameliorate their lot by obtaining a little education.

The class which should occupy more of our attention and excite greater interest is the immense majority, that which

has some elements of instruction, and which earns on an average four francs a-day.

The workman who gets such wages, and whose wife is industrious, if both are economical, may live at Paris in a position comfortable and far above want. A striking result must convince us of this.

In 1847, when prices of provisions were very high, the inquiry has shown that the expense of the essential articles of food of the whole of Paris, rich and poor, presented a total of 226,863,080 francs, for a population of 1,053,897 souls, giving per head for annual subsistence, 215 francs, 26 centimes. For 300 working days this is only 71 centimes (about 7*d.*) a-day.

Consequently, the food (not including potable matter) only amounts to about the fifth part of the wages of our workmen of the average class, such as are seven-eighths of the Parisian population. The surplus price of bread was 20 centimes in the year of scarcity, 1847. Now, if the workman himself had paid this excess of price, he would have spent for his food 91 centimes (9*d.*), that is, a little less than a quarter of his wages. The other three quarters would have remained to satisfy his other wants, and those of his family.

It was thus that, even in 1847, the depositors at the savings bank of Paris, a great majority of whom are workpeople, were able to deposit, notwithstanding the scarcity, 31,690,951 francs, by 243,450 persons, comprising therein those who deposited more than once in the year.

Between an ordinary year and the year of scarcity, the difference deposited in the savings bank was only 4,800,000 francs; depositors, 183,449; average amount for each person, 26 francs, 16 centimes. Consequently, the entire effect of a year of scarcity was, at Paris, not to impoverish the savings

bank, but to decrease the average amount of deposits 26 francs, 16 centimes, for each depositor: so vital was then the public prosperity!

The inquiry has shown, for the first four months of felicity promised to the workmen from the days of February, 1848, the number of workmen out of employ. Workpeople of both sexes discharged during the first four months of that year, 186,405; or nearly 120,000 men, and 66,405 women. These numbers were nearly doubled during the succeeding months, whence a loss of wages resulted—

For workmen, amounting to about - -	130,000,000 francs
For workwomen - - - -	30,000,000
Total - - -	160,000,000

Here there is for the operatives of the intermediate class, earning from 3 to 5 francs a-day, 160,000,000 francs wholly lost!

On the other hand, 18 centimes (about $1\frac{3}{4}d.$) a-day was distributed to 300,000 persons of both sexes and of every age for about six months following the suppression of the *ateliers nationaux*, making 9,700,000 francs of charitable contribution, say 10 millions (400,000*l.*).

An absolute loss, therefore, results to the average class of workpeople of Paris, from February to December, 1848, of 150 millions of francs (6,000,000*l.*).

These are positive results, sufficient to show what sort of felicity these great reformers of labour, of the state, and of the family, procured for the industrious classes in whose hands they placed arms, and whose services they recompensed by misery.

Enormous as were the losses sustained, they were not in the same proportion for the different quarters of the metro-

polis. The Faubourg St. Antoine, and the adjacent faubourgs, had to submit to the most severe suffering.

Look at the comparative statement of the manufacture of furniture, principally carried on in the Faubourg St. Antoine. In 1847, it amounted in value to 137,145,246 francs; in 1848, to 34,716,696 francs. It followed, then, that the workmen employed in this manufacture must have been reduced in their earnings by three-fourths. Such a loss fell principally on the Faubourg St. Antoine, and with fearful intensity.

It was thus that in this faubourg, in June, 1848, the genius of destruction found it most easy to recruit victims, and this faubourg it was he chose for the theatre of his triumphs.

One of the leaders who preached with a most fatal success the reform of labour and the suppression of property, was surprised in a house facing the burning workshops of this faubourg, attacked and defended with equal determination. With a view of explaining his presence, he declared that he stood there to admire the *sublime horror* of the spectacle! Every one has his own opinion of the sublime, even as regards the Faubourg St. Antoine. I will explain mine, and I hope all its inhabitants of every class will agree with me.

In 1847, the most eminent artist of this quarter, the celebrated Gambey, died still young, and in the full vigour of talent. For twenty years this artist occupied in Europe the first rank for that truly miraculous precision which he imparted to astronomical instruments, either invented or improved by himself. Many celebrated observatories had acquired by his labours new means of advancing in their discoveries and application to the laws of nature.

Without being able to appreciate, in a scientific view, the

superior and rare merit which characterised M. Gambey, the industrial population of the Faubourg St. Antoine felt that they had lost one of their illustrations. They desired, in a body, to render their last homage to the great workman whom it loved as well for his virtues as for his kindness and charity. They desired to bear on their shoulders the remains of such a citizen to the place of burial, Père la Chaise, the elevated point whence the Faubourg St. Antoine, and the whole of Paris, spread out into an immense amphitheatre, like Life at the feet of Death.

Such, then, and so great, was the pious feeling with all the children of labour, in presence of whom I had received the mission of expressing the public sorrow, in the name of the Academy of Sciences. This Academy, indeed, had consecrated to itself Gambey, and had enrolled his name in the glorious list, for the section of mechanics, with those of Vaucanson, Montgolfier, Carnot, Monge, and Napoleon.

To this immense auditory I addressed these last words:—"All you, pupils of the arts and métiers, apprentices, masters, and workmen of various professions, who press in vast crowds around the grave which holds the mortal remains of the brother over whom we weep, see to what an eminence of glory you may rise, by seeking to attain perfection in the several labours to which you are devoted. *Imagine a concourse of the French artists, and those of all the nations which cultivate the sciences and aid the advancement of the human mind!* An immense void has been made in this concourse. Labour with indefatigable ardour to prevent France from losing her rank. If you use with advantage the inestimable gifts you have received from nature, believe me, in our country, liberal and just honours will be bestowed on you, as they have been on the most modest of men, and you will be sought out that they may be bestowed on you.

"Let us now, in the name of the National Institute of Sciences, Letters, and Arts, inscribe on the tomb of our celebrated colleague those words which must cause every heart endued with noble feeling, from the highest to the lowest, to palpitate : —

"To the Workman — to the Foreman,
who became
A member of the Academy of Sciences."

Could you then have seen the energetic enthusiasm of those thousands of workmen who pressed about that tomb, — could you have heard the murmurs of applause, half-repressed by the sentiment of respect for such a solemnity, — you would have declared them to have been some favourites of war, who were whispering a vow, as they marched to the fight under the control of discipline, that they would be victorious!

This will be for me, during all my life, for my feelings, and for my reason, the sublime spectacle — mark me! the sublime spectacle — of the true Faubourg St. Antoine.

The vow thus uttered was no vain form of words. Four years later, when this concourse of nations was realised which I shadowed out in 1847, the courageous, the ingenious faubourg, attained its place of honour by obtaining four council medals instead of one. Let us recur to the artists who have obtained them, two for the fabrication of mathematical instruments, and two for products connected with the fine arts.

First on the list is M. G. Froment, who will, I hope, one day fill the void made by the death of M. Gambey, whom he already approaches for the admirable precision of his microscopic divisions, and for his fertility of combination in philosophical instruments.

Next follows M. G. Hermann, who, endued with a genius

for mechanics, has been able, by varied, simple, and new combinations, to resolve the problem so delicate, to reduce to atoms absolutely impalpable, the matters required in many important cases by pharmacy, chemistry, artistic painting, and the improved trituration of cocoa.

In the products having relation to the fine arts, we cite with honour M. Delicourt, who is distinguished, amidst the manufacturers so numerous in the Faubourg St. Antoine, for decorative papering. His papering for rooms, full of effect and energy, appears to possess the character and *éclat* of the most admired frescoes.

We now come to M. Fourdinois, who has determined to show to what height the imagination and skill of the industrious cabinet-makers, who are the life and wealth of the faubourg, can be made to attain. The raw material is of no comparative value in the priceless work, the success of which I am pointing out to you. It is one of our common woods, walnut, the black veins of which, admirably carved, make us forget mahogany, ebony, and rosewood.

Never was carving in wood bolder, broader, and more animated than in the four beautiful female figures, of noble and severe forms, emblematic of the four quarters of the world, and in the four hounds crouched at their feet, which also seem inspired with the same austere beauty as the figures. It would appear to be the work of an artist who could use the chisel in peace with a hand as intrepid as he would wield a sword in war.

Is it not glorious that one of our faubourgs, which seemed crushed under the calamities of civil discord, should start into new life, and acquire twofold more artistic and manufacturing honours than were obtained by the celebrated cities of St. Petersburgh and Moscow, or Florence and Rome, or Milan and Vienna.

I should be truly afflicted if our workmen could suppose that I had preference and eulogy only for one of our faubourgs. I should be most unjust.

If you will visit the moiety of the circumference of Paris, at the east from Montmartre to the Gobelins, the faubourgs you pass through will furnish evidence of our superiority, which may be resumed in a word. In the universal concourse of nations, this moiety of our suburbs has obtained more prizes of the first order than the three largest Capitals of the European continent taken together.

Cease not, my dear fellow citizens of the Faubourg St. Antoine, and of all the other faubourgs and the quarters which are connected with them, to prefer, for the happiness and honour of the country, the peaceable glory of the arts to the false seductions of civil discords. Listen always, as you have done latterly, to the voice of your most sincere friends, and to the voices of others being dearer and that speak more sweetly to your hearts.

It is under the shadow of the domestic hearth, in his hours of repose and leisure, that the workman seeks, amidst his children, the devoted wife, the laborious companion who ministers to all his wants as well as to his real happiness. It is there he hears from her advice dictated by prudence and reason, there that he can appreciate the wisdom of her lessons — often too much misconceived — on economy, temperance, and moderation.

On comparing, as regards these qualities and this devotedness, the wife of the French workman with the wife of the English workman, and still more with the wife of the workman of the United States, we cannot but be struck with the superiority she presents, particularly as relates to domestic concerns.

May the authority, — I use the term advisedly, — the au-

thority, mild and kind, of the wife and the mother, be felt more and more in the interior of the houses of our workmen, first to increase, and render common, regularity of life among the Parisian artisans, and then to reform the character of so great a number of children full of intelligence,—children who would become remarkable men, if they did not commence from their youth to become, what in terms ignoble, but often too correct, is called *un gamin de Paris.*

Do not let his defects, his impetuosities, vices in the germ, be matter of amusement, which, rightly directed, would become so many good qualities and virtues. Let us reason with him as if he were on the point of becoming a man, with a view of teaching him self-respect, and of guiding him by emulation, by the sentiment of honour, so powerful amongst us even from infancy: thus shall we render him worthy of esteem.

I am wandering apparently from my subject, although I am proceeding without losing sight of my desideratum, the glory and the future well-being of Paris, considered, not only with relation to its opulent and ostentatious classes, but before all in its vital members, its labouring population.

After having given you some idea of all that our capital has suffered, and signalised some of its partial triumphs, I pass to the metropolis of England. We shall derive other lights from such a comparison.

How can I give you an idea of London in regard to its prosperity, opulence, grandeur, and its intellectual advancement, the result of the wealth and discoveries of two happy centuries.

Imagine a monster city, occupying a territory equal in superficial extent to the whole department of the Seine, and containing a population as numerous as our five departments of Normandy! Imagine this immense population spread over

the two banks of a river, which bears vessels of the largest burden up to the docks forming its maritime portion. Imagine the ships of all countries lying at anchor in order from the last of the bridges, arrayed like an army of giants in transversal ranks, succeeding each other almost without interval for a league in length, and leaving in the middle of the crowded mass a space animated with vessels, either steamers or under sail, which are going to or coming from all quarters of the globe. To supply the insufficiency of this first natural port, imagine five groups of floating docks, which receive the vessels devoted to the commerce of the East Indies, the West Indies, and other special sources of commerce. Imagine by these means a surface of water always available, never subject to the rise and fall of the tides, and nearly equal to the area of the Champ de Mars. Imagine around these docks, establishments of warehouses and workshops for the rigging and armament of the ships of commerce and war. In this first city thrive an infinity of industries which are not to be found at Paris, and of which Paris has not even the idea. Such is the maritime city, which includes, like three continuous faubourgs, the ports, the towns, and the arsenals of Greenwich, Deptford, and Woolwich.

Immediately above this capital of the sea, ascending the Thames on the northern side, we come to the City of London, properly speaking, with the infinite variety of its workshops, its enormous factories, deriving motive power from so many steam-engines, which, with the dwelling houses, are heated by so large a consumption of coal, that the atmosphere is darkened for three parts of the year. In these establishments are given, by the united powers of man and of steam, the last finish to inconceivable quantities of products intended for all nations of the globe.

Quite at the west, that is, in seafaring language, to wind-

ward of the Cyclopean atmosphere, and freed from its darkness during the gloomy season in which the rainy winds from the Atlantic are prevalent, a third city, that of the luxurious arts of opulence and pleasure, of the aristocracy and the government, stretches along the left bank of the Thames. This is interspersed, rendered healthy, and embellished with a continuous succession of immense public parks, sown with rivers, lakes, adorned with meadows, and shaded with trees which count more than a hundred years. On the bank of the imperial river shines out, in splendour all its own, a new legislative palace, built on the site of the old parliament houses which were destroyed by fire. The new construction will not be covered by an outlay of 2,500,000*l.* It is built and decorated in the style of architecture borrowed from the time of the Norman Conquest, in the country where respect for ancient laws and manners guarantees the permanence of those now existing. On the side of this is the basilica, formerly Roman, of the monastery of the West, left standing in spite of the Reformation. There are deposited the remains of the great men of the three kingdoms,—this moral and religious wealth of an illustrious people. They are collected with pride in this temple of Westminster, to honour and immortalize the city of Parliament, which flourishes by their laws, their glory, and their eloquence.

Such is the majestic *ensemble* of the capital of an empire where a hundred and fifty millions of subjects send hardly ships enough to supply the increasing consumption of an accumulation of two million and a half of inhabitants.

During three centuries and a half, sciences, letters, and arts have flourished in the city, illustrated in turns by Newton and Davy, by Shakspeare and Milton, by Rennie, who built bridges bold and gigantic over the Thames, and formerly by Wren, who built St. Paul's, the greatest classical

monument of religious architecture in England, and the first in Europe after that of St. Peter's at Rome.

We do not blush to avow that Paris, with its little million of inhabitants, and its secondary river, appears by the side of London as formerly did David before the giant Goliath.

With so great inequality, we inquire, with anxiety, what was the issue of the solemn competition that these two antagonistic cities offered before all the nations?

In the concourse of the Universal Exhibition, these were the honours conferred on the works of art and industry acknowledged as absolutely superior: —

On London, having 2,500,000 inhabitants, thirty-five council medals, or honours of the first order.

On Paris, having 1,053,000 inhabitants, forty-one council medals, or honours of the first order.

That is, for each million of competitors —

For London - - -	14
For Paris - - - -	39

And what renders it certain that the balance was not unjustly inclined in our favour is, that *half* the judges of this concourse were English, and the *ninth part* French.

I will hereafter explain the numerous reasons of the superiority of which I have stated the summary proof. I shall content myself now in stating a primitive cause connected with the very constitution of society in the city of Paris: it is the division really marvellous, and the multiplication of independent workshops in this capital. Since 200,000 male workmen reckon in Paris 65,000 heads of establishments, there are consequently, in constant operation, 65,000 intelligent persons responsible for success. They are interested at once, by an attention to their property and their honour, to seek incessantly for improvements and new processes in the course of their art, in the form,

utility, and beauty of their products. There are 65,000 superiors always compelled to look to and superintend the operations of their subordinates, with that eye so judiciously characterised by the admirable poet of nature and good sense, by La Fontaine, who says —

"Rien n'est tel que l'œil du maître."

Thus the same multiplicity of the heads of industry, which present to our workmen so many various chances of advancement and fortune, is at the same time one of the most powerful causes of the superiority of Parisian art, in its admirable variety.

I cannot here give you even an imperfect idea of the numerous and special industries which characterise this Parisian superiority, of which I have indicated the triumphant consequence. It will be more simple, more short, and more intelligible to divide these industries into four principal groups.

With a view of avoiding prolixity, I shall limit myself to stating for each group the number of council medals obtained in the two cities of Paris and London for each million of inhabitants.

Every million of competitors has received —

1st. For the arts relating specially to mechanism and machines, in Paris 7 council medals, and in London 6.

2nd. For the economical and chemical arts, in Paris 4 council medals, in London 1.

3rd. For the graphic and geometric arts, in Paris 8 council medals, in London 3.

4th. Lastly, for the fine arts, and for all the arts in which elegance of form and perfection of taste are essential conditions, in Paris 20 council medals, in London 4.

It is impossible, I confess, to present to you such results without feelings of just pride, and without remembering

with gratification all the progress that, during a quarter of a century, perhaps in some sort by our teaching and by our incitement, Paris has done to arrive at these magnificent results.

You must not imagine that the inhabitants of the banks of the Thames will allow you always to boast of your success. Nothing would be more dangerous or fatal than such an error. The English, as compared with us, are a people who appear to advance slowly, but who do advance, and advance always with the same perseverance, without ever receding. They will redouble their efforts precisely in the crafts and arts in which you have proved yourselves superior.

What have they not borrowed from the *élite* of our operative classes? Since the revocation of the edict of Nantes, which furnished them with the art of weaving silk, as in Spitalfields, to the time of our revolutions, which supplied them formerly with Brunel, the great engineer; and more recently with Morel, the eminent jeweller; Weicht, the carver *par excellence;* Bontemps, the skilful manufacturer of glass for the Crystal Palace; and Marochetti, the celebrated sculptor, which have procured them four council medals borrowed from the Continent.

Be assured the English will continue to demand from us our designs and our draftsmen for all the products of elegance, and our artisans and artists in the crafts specially French; and then, as they did in 1851, they will compete with us without the least hesitation, making use of our soldiers and our arms. They will finish by borrowing from us even the art of possessing taste. They have already done this in a case I must submit, as a great example, to your serious consideration.

About a century and a half ago, some of the most eminent and conscientious scholars of England conceived the idea of undertaking a periodical work, having for its object

the reformation of bad manners and bad taste in their country. To cite only one example of the great success they obtained, it will be sufficient to refer to an article written with inexpressible beauty by the celebrated Addison, the prose of which has for the English the poetic suavity and natural expression of our Fenelon. The SPECTATOR commences by observing that the beautiful French gardens were less unlike nature than the gardens of England. This may seem somewhat extraordinary, since the terms of comparison and preference, as regarded the approach to nature, were the gardens of Louis XIV.! Those, however, of Great Britain then resembled the plantations of the excellent Baron of Bradwardine, which combined, under all forms, the beauties of bears by the side of sculpture, and trees and shrubs cut in every variety of geometric line and curve.

Once attracted, although at a considerable distance, by the consideration of nature, Addison abandons himself to all the graces of his imagination. He asks why England, with her admirable verdure and the magnificent shades of her luxurious vegetation, should not advance a step further? Why every possessor of a field or meadow should not embellish it by ornamenting its boundaries by evergreens, which would always look agreeable, sowing the ground near them with some pretty wild flowers? Why, proceeding from harmony to harmony, the roads, the ways, the paths, should not be formed in gentle curves, following the graceful undulations of the ground? Why the fields, the meadows, the woods, happily combined, should not add beauty one to another? The enchanter little thought that he was, with the hand of a master, painting the natural splendour and the charming simplicity of what would one day become the beautiful gardens of Great Britain. Two successive generations had not passed away, and England had changed its

aspect; and it is now for us to take lessons to metamorphose the nakedness of our fields by the addition of beautiful and simple ornaments to their monotony in a state of nature, which our greedy cultivator is unwilling to interfere with, lest a tree or a shrub should rob his corn of a single ray of sun.

This perfect taste, exhibited in all the beauties of ingenious cultivation, is so general in England, that not a square is to be seen in the cities without trees and shade, nor a cottage or country house which has not its porch, its doors, and windows, embellished by climbing plants, or festooned with vines. A little parterre is always added in the front of it, be it only a few yards square, to give an idea of rurality, and to shut out from the public road the blessed secrecy of *home*,—of *home*, a term sacred indeed, and sanctified among the English, combining in itself all the feelings and all the affections of the domestic hearth, family, and country.

Most assuredly, if the English can raise themselves to the first rank for taste in the ornaments of which the culture of the land is susceptible, they can also attain it in the industrial arts, in so far as may be requisite to acquire the sentiment of grace and the production of beauty. Reflect on this!

To enable us to judge if Paris can preserve, as compared with London, its artistic pre-eminence, let us follow its progress during the third of the century which has passed, in spite of infinite and deplorable obstacles.

How admirable a physical progress is presented to the observer by the city of Paris between 1814 and 1852! At the former epoch the population of the capital was less than 700,000; it is now 1,054,000, exactly what it was in 1846.

All that three years of calamity, one of scarcity, one of

revolution, one of cholera could produce, is to have rendered stationary, during five years, a population which only requires to be increased by 33 per cent in thirty years to be doubled in fifty years.

By the acquisition of nearly 400,000 inhabitants since the general peace, Paris has augmented, especially in the faubourgs, that industrial crown, thanks to which the capital is now the first among the manufacturing cities of the European continent.

At the same time that the exterior part of Paris has increased in its buildings, everything has been done to render healthy and embellish the older portion of the city, to render it everywhere more convenient for commerce and less favourable to disorder. Its streets, its squares, its quays, its bridges, its boulevards are enlarged, with gentle inclinations of level, and with sewers to carry off water. The public palaces of the Louvre and the Council of State are finished; the Hotel de Ville is rendered worthy to represent the opulence and civilisation of the metropolitan city.

The well-being of the people has advanced in proportion to the embellishments of the capital, and much has been done to inspire the laborious classes with a love of economy and the necessity of foresight.

The savings bank, which in 1817 possessed nothing, on 1st January, 1845, presented 179,000 depositors, and 112 millions of francs deposited.

In 1848, an arbitrary act suspended by violence all possibility of reimbursement; a second act, five months later, ordered a complete and compulsory reimbursement. It was not even allowed to leave a single franc on the books of the old depositors. Later still, a third act, in 1851, struck a severe blow at the legislation which regulated this institution as regarded the new depositors.

Strange that under the *régime* bearing the captivating name of republic, and when the word "people" was echoed almost to satiety, the most severe attack has been levelled at the only modern institution truly great and truly important in favour of the operative classes! During the last summer I stood alone, stigmatised as a friend of paradox and error, when I was desirous of defending, inch by inch, the institution which Larochefoucauld-Liancourt and his friends, in their innocence, regarded as a support of popular morality.

Many other are the wounds inflicted on national morality, not only during the last four years, but during five-and-twenty years. While so much has been accomplished for the material amelioration of this metropolis, we may look in vain for any measures directed to its moral improvement.

I have often contemplated with pleasure and gratitude the magnificent openings, such as the Rue Rambuteau, the Rue Soufflot, and the Rue de Rivoli extended to the Hôtel de Ville, rendering more salubrious places lately fearful to contemplate; but in vain have I continually asked myself why the morals of the city had not been the object of a like solicitude, to make openings for the free passage of honour and virtue, by destroying the dark courts and alleys where vice and crime had taken their abode? I have asked myself why demoralisation had not been at least entrenched, to prevent its contagion from spreading?

We will not go further back than a quarter of a century. After St. Simonianism, which was but half mischievous, had fallen under ridicule, other reformers of society seized on it as their heritage, not for the little good that the ephemeral sect professed, but for the vice and corruption which in reality it contained.

Contempt of family ties was carefully retained! Community of woman survived; and none but the votaries of the

new philosophy could discover by what eccentricities she was to replace the holy, humble, yet sublime duties of a wife and a mother.

The St. Simonians did not maintain that patrimonial property was an inexpiable crime. They confined themselves to the allegation that it was ill distributed. They required the heir of an estate to confide to them his heritage, in order to its better application, by apportioning it amongst all, according to their merit and their works.

The successors of the St. Simonians discovered that it was not fitting to suffer even this remnant of *inégalité* to subsist. They did not admit the doctrine that each should acquire property according to his merit and his industry. The compulsory equal division of property appeared to them infinitely more social. They did not admit that the reformers of society were bound to wait until the owners should, of their own will, abandon their estates; they discarded all ideas of so slow a process of spoliation, and were determined to make shorter work of it, without consulting those who might deem they had some shadow of right to their own property.

But it was necessary carefully to conceal this extreme object of their dark projects, not to awaken alarm too precipitately. Before admitting the veil to be withdrawn, so that the imaginary edifice might be visible to all, or rather before it should be discovered that behind the veil all by which modern civilisation was to be replaced was chaos and confusion, the innovators judged it more prudent, with profound dissimulation, to sap the fundamental bases of our social order.

Their first object was to fill the minds of the masses with disgust, to persuade them that their lot was each day becoming more insupportable; and that at a time when peace abroad, and abundance of occupation at home, vivified by the

progress of the arts and sciences, were producing wonderful and beneficent results.

The workmen were told that the masters required more work than human strength could bear, and that the sources of existence of the unhappy operative were in course of destruction. In vain was it attempted to be shown by me, that for half a century the length of life of the French operative had increased on an average *ten years.* The calumny was repeated, but no attention was paid to the reply, and the hatred of the operative against his employers and against his country was in every way fomented. Exceptional cases were cited of labour ill rewarded, crushed as were certain trades by temporary competition, or declining by the introduction of new processes of manufactures which supplanted the old, and were leading to their compulsory abandonment. Examples of insufficient wages were bruited about; but it was not added that this frequently arose from idleness, ignorance, or incapacity.

The position of particular individuals, afflicting, certainly, was pointed out, and it was asked, with feigned indignation, if it were not time radically to change the proportion of profits between the employer and the employed?

In a country where industry is free, where any body may choose between hundreds of professions, and may engage in them, if he will, uncontrolled by another, it was pretended that the operative was a slave and a victim. Not only were human things the most natural, the most legitimate, the most respectable, attacked and vilified; the genius of disorganisation carried still higher its daring, and by way of complement to its first mendaceous dogma, "*La propriété c'est le vol,*" he dared to add, "*Dieu c'est le mal.*" It remained for Socialism to surpass Atheism in the infamy of its doctrines.

From the year 1840, on the mere rumour of the possibility

of war, the modern reformers had put their hand to the work of revolt. They began by causing it to be communicated to the heads of establishments that they must submit to the law of coalition, diminish the hours of labour, and increase wages, pronouncing the pain of death on all workmen who would not join the reform combination. Alas! society would not be warned by such events; apparent order was re-established. Then the apostles of darkness resumed their mission of exciting first dissatisfaction, then despair, and finally revolt.

Seven years were yet wanting to bring to an issue this great enterprise of Socialism — seven years in which all that was material, industry and commerce, did flourish; public prosperity increased; whilst envy and hatred grew in the same ratio as the general felicity.

This peaceful state of things became disgusting; but when it was imagined that that which by fatuity was termed "*la révolution de l'ennui*" (as if the laborious life of a whole people could be regarded as a party of pleasure) had been accomplished, every one who had anything to lose, faith, law, property, family, awoke at once from his dream, and found himself and all he possessed or valued on the brink of an abyss.

Far be it from me to utter a word here which may have relation to the direction of human affairs in this or that person, or to approach what are called politics. I only see and will confine myself to the attack made on society, on the country, in their welfare, their peace, and their morality.

That which above all has given me the greatest disgust in the excitation to revolt by the masses, who were driven as flocks of sheep to overthrow the ramparts of order and civilisation, was the adulation of those who had corrupted them. They besotted the operatives by their flattery, and im-

pudently excited expectations impossible to be realised. They urged the boldest and most daring to crime, regardless of the consequences; and on the minds of the more moderate of these misguided men, they impressed ideas destructive of their peace and fatal to their happiness.

Allow me to cite but one example of the ills produced by these apostles of Socialism, these malefactors, without whom it may be affirmed the revolution of 1848 would not have produced one tenth part of the calamities that ensued. It is not from afar I need deduce it, it is here, here in Paris, in the populous quarter in which stands this Conservatoire where we are now assembled.

Hear the Committee of Inquiry, of whom I have already spoken, appointed by the Chamber of Commerce of Paris, on the state of industry in 1847 and 1848.

"A manufacturer of the Rue St. Denis, himself formerly on operative, had as a foreman one of his friends, an ancient fellow workman, whose attention to business, although not irregular, differed essentially from what it had been before February, 1848. He exhibited indifference and discouragement. The master, addressing his fellow-labourer in terms of friendship, sought his confidence, and endeavoured to ascertain the cause of his sorrow. Was he ill? No!—Had he any pecuniary difficulty? No!—Or family anxiety? No! 'But,' said he, 'I have a feeling which I cannot overcome; I have no more heart for work. I know it's wrong and foolish, but since this d—— revolution, my hands are not inclined to work!'" Thus it is that the effects of violent commotions are not easily effaced, and years are requisite to get rid of the traces of a momentary disorganisation.

I am here speaking of an honest and good workman, whose heart is not imbued with any evil sentiment, and whose mind is not corrupted by any pernicious doctrine. He is merely

one of those operatives who have been misled and seduced by hopes that cannot be realised. When he found himself, by the necessity of things, obliged to descend again into the realities of the actual world, he could not breathe without uttering a sigh, or work without feeling a hopelessness which destroyed his energies. Yet this man held a position in the factory hardly second to the head of the establishment; but notwithstanding this position, and his necessarily high wages, he could no longer appreciate and enjoy the advantages of his situation.

What, then, must be the case with reference to a poor workman, misled by pernicious doctrines, to whom had actually been promised a participation in the property of others, a place in the government, and a share in the vanities of this world, — those vanities that the most fervent friends of *égalité* never refuse, in the shape of honours and distinctions? What must be the case with reference to one of the so numerous members of those clandestine societies, whose meetings are held with the utmost secrecy for the purpose of swearing the commission of crime, — of those societies, whose seditious atmosphere is more besotting and more dangerous than the resorts of ordinary drunkenness?

It is with such men that labour seems not only degrading and revolting, but detestable and completely impossible.

These are the unhappy beings that the true spirit of Christian charity should induce us to succour, to bring again into the paths of right, and, if possible, to console. How much is it to be desired, that from the pulpit the treasures of benevolence and mercy were poured out upon these erring souls, to bring them back to the love of their fellow men, and to reconcile them with that society which they have been induced to swear to overthrow, from the highest to the lowest! The triumph of force is as nothing to heal such wounds. It is to the kinder feelings an address must be

made, if we would reconcile with humanity the men who have been familiarised with the idea of social destruction.

Instead of flattering, in a cowardly manner, the workman, and exciting in him an overweening vanity, is it not more humane, more wise, and more in accordance with his true interests, to make him understand how little he possesses who has merely the strength of his two arms as a dependence, if to this be not added the faculties of intelligence, unfolded by instruction, and rendered fruitful by labour?

When I reflect on the immense seduction which may be effected by flattering evil instincts, far from being discouraged, I feel full of hope at the idea of the good that may be produced by addressing ourselves to the noblest dispositions that Providence has implanted in the heart of man to cause the triumph of truth over error.

Allow me to say to the Parisian workmen in conclusion: —"You are citizens of the most illustrious city of the earth, — of the city that foreign nations, abandoning all prejudice, recognise as the home of science, the sanctuary of taste, and the metropolis of civilisation. All the treasures of intelligence, accumulated by national opulence, — libraries, museums, public gardens, primary, secondary, and superior schools, — all are open to your interests or your pleasures. The public buildings remind you of the patriotic grandeur, at the same time that they present to you, in their several parts, models for the arts you practise.

"In the land of your birth there is not one of the paths which conduct to happiness, to opulence, to distinction, to renown or glory, in which you cannot advance, with unlimited rapidity if you have genius, more slowly, but not less certainly, if you have discretion and merit. The whole country is interested in your success, and acknowledges with gratitude your superiority when you triumph in the contests

of industry. No one has superior privileges to you, and you may command the fruits of success, of labour, and courage, whether in peace or war. The majority of the most illustrious marshals of France have proceeded from your ranks, and have won their way by victory; and the marshals of industry, for it too has its marshals, have this very year won their stars and their epaulettes on a foreign soil, at London, amidst the general applause of all nations.

"Judge, then, of the unmerited contempt heaped on you by those who say, to irritate your pride, that you are *parias*, *prolétaires*, without present happiness, without good in prospect, and always unhonoured. They who thus speak of you are calumniators of your destiny, they are the declared enemies of a society developed and perfected for ages by all the men whom France has produced superior in the sciences and in the arts, and whose pre-eminent intelligence has been subservient to useful industry.

"Let us cement the alliance of physical with intellectual force, let us cement hearts as well as intellects, let us find in the hierarchy of labour only a continuous pyramid, the steps of which, accessible to all, allow each one to ascend according to his labour, his skill, and his talent. Instead of envying, hating, and attacking each other, let us mutually extend between us the hand of fellowship, to enable all to arrive at the summit more speedily and more easily. It is by such a course that the country itself may be raised to its highest pitch of magnitude and fame.

"If we will act so wisely, let us have no apprehension that any city of the old or new world will rank above our illustrious metropolis. Let us look forward to the success in store for us, which I will venture to predict will surpass even that we have just achieved at the vast industrial and artistic competition, the result of which has so largely augmented our national glory."

LETTERS OF M. MICHEL CHEVALIER.

LETTER I.

Good ideas may prevail, although the public, admitting their merit, sometimes doubts the success which is reserved for them. The Exhibition of Industry, devised, after the treaty of Campo-Formio, as an appendix to the fêtes celebrated in honour of the success of our arms in Italy, became with us a periodical solemnity, continually augmenting in *éclat* and utility. In 1849 it was one of the signs that France exhibited of the vitality which survived in her after the violent trials of revolutions. The building in the Champs Elysées was hardly demolished, before the idea of the Exhibition crossed the Channel, acquired on the soil of England new and greater proportions, and gave birth to the vast and brilliant gathering of which we are now the spectators. It is thus that a simple display of goods upon a stall, principally designed as some novelty in the accustomed arrangements of public fêtes, gave rise first to a periodical national solemnity of considerable interest, and finally created that now exhibited at London, and which, be assured, is nothing less than a great event.

This is hardly the place to recriminate against one's own countrymen; the feeling with which we are inspired in London in the Universal Exhibition is that of concord. How can we shut our eyes, however, since history will not be

silent ?—for history will occupy itself with the Universal Exhibition as one of the "great facts" of our day. The idea of this solemnity had its origin with us. In 1849 it was very formally considered whether it would be advisable to give to our Exhibition the character of a concourse of all nations; the government declared itself favourable to it, and made it—and in this it erred—the subject of an official debate in the Chamber of Commerce, and an intrigue, notoriously concocted at Paris, caused the majority to decide in the negative; in submission to which the government, supposing, with an excessive humility, that the opinion of the country was against it, relinquished its own desire. Thus was wrested from us the full development of an idea which, having originated with us half a century ago, had received amongst us, up to the present time, all its successive enlargement; thus did we allow the opportunity of taking once more the initiative of great and generous designs, which has so often distinguished us in the midst of civilisation, to escape us. But let us repress regrets, which would only serve to lessen the admiration that the spectacle now offered to us ought to inspire. Save for our national "*amour propre*," there is no reason to regret that the Universal Exhibition on this occasion, which will not be the last, is held in London.

First, London is more accessible by sea than Paris; secondly, our custom-house would have created difficulties; and lastly, and above all, two circumstances, which have had a prominent influence on the London Exhibition, would not have been realized with us. I mean to say, the manner in which the Exhibition has been established independently of the government, and the species of building which has been erected for it, and which, in the opinion of those who are most competent to judge, is one of the greatest ornaments of the industrial festival.

Yes, this Exhibition was projected, organized, and completed, from first to last, without governmental interference. The arrangements were made, the plans prepared, the works executed, without the authorities claiming the initiation, or even desiring to take the patronage of the enterprise. For such an Exhibition there have been with us twenty times more ministerial ordinances issued, official circulars signed and published, a hundred times more scraps of paper blotted in the bureaux of our Ministry of Commerce, than in those of the Board of Trade in London. Doubtless a distinguished personage, whose official standing is very high, Prince Albert, took the largest share in the arrangements, but it was in his individual capacity; it was his personal influence alone, more considerable than his rank, that he brought to bear.

The circumstances occurred thus. In the private meetings of a society, which exists not by the investiture or permission of government, but by the spontaneous zeal of its members — the Society of Arts, — Prince Albert, who is one of its members, suggested, on the 15th June, 1849, in terms which do him the greatest honour, and which I shall more particularly notice hereafter, the idea of a Universal Exhibition. The proposition was warmly embraced by the Society, who immediately began to carry it into effect by addressing personal communications to the heads of the industrial establishments. No law, no ordinance, no order of council, however, was issued. A small number of persons only, — consisting of the Prince himself, and three or four others, who were worthy to be his coadjutors in this magnificent design,— as private individuals, held meetings, discussed, proposed, and made provisional arrangements. The enterprise was admitted to be practicable. Good! The Committee of the Society of Arts laid down the bases of it in general terms. After having taken time to consider, and after feeling a little the pulse of

the public, which was very natural, voluntary subscriptions were called for, with a view to obtain the funds to defray the expenses, including 20,000*l.* for medals and honorary rewards; 65,000*l.* was thus soon subscribed, — a large sum, but manifestly insufficient. What then was to be done? Messrs. Munday, the well-known contractors, made the spirited proposition to undertake the enterprise at their own risk. They were thanked, but their offer was declined. This would have created an inconvenient control, — more than inconvenient, — notwithstanding the urbanity of the Messrs. Munday, and their proposed intention to submit themselves entirely to the founders. A small number of men, of considerable responsibility, then appeared upon the scene. These eminent citizens assumed a pecuniary responsibility of large amount, in case the receipts from the sale of tickets should not cover the expenses. One individual, a member of parliament, Mr. Peto, first set down his name for 50,000*l.*; after him followed several others, amongst whom was Mr. Jones Lloyd, recently elevated to the peerage by the title of Lord Overstone, a skilful financier, formerly a banker. The financial notabilities of the city also came in aid, and thus a mass of individual guarantees amounting to 200,000*l.* was obtained, on which the Bank of England offered to make advances. From this moment the enterprise was safe. Columbus had obtained his ship. Nothing now remained but to send for the architects. But time pressed; we were in June, 1850, and the opening of the building, not yet even begun, was announced for the 1st May, 1851. In all these proceedings, the only interference that had a semblance of being governmental, was the official nomination by the Queen of the Royal Commission. This was necessary less to obtain the adhesion of the principals of industrial establishments in Great Britain, than with a view to foreign

nations, the concurrence of whose governments was necessary. It is worthy of remark, that at a certain period the government was solicited to take a great share in the direction of the enterprise, on the ground that it was indispensable to its success: but, wisely appreciating the part it should take, and justly confiding in the discretion of a public long habituated to the management of its own affairs, it without hesitation declined the offer, which in any other country would have been an irresistible temptation; and events have shown the wisdom of this decision. The Exhibition was opened at the period prescribed, every thing was done in order, every thing went well. As to the financial situation of the enterprise, it is quite satisfactory. A sum amounting to 200,000*l.* was requisite, but at the moment I write 150,000*l.* beyond that has been received, without resorting to the guarantee of 200,000*l.*, of which Mr. Peto took the initiative. The receipts at the doors continually augment, they are now 8000*l.* a-day; it is certain that there will be a large balance in favour of the enterprise.

I am much struck every hour with that quality of the English which exhibits itself by acting in concert for the common good, by bringing to bear spontaneously from amongst themselves a collective force before which all obstacles vanish, all opposing interests bow in respect or fear, without any necessity on the part of government to submit its subjects to a kind of military discipline, to ascribe to each his position, or to give him the watchword and countersign. I would that my own country possessed this inestimable quality, because it is a characteristic of liberty truly understood; and I think that without this real liberty, there are no prospects such as one desires to anticipate for France. It is thus only that a nation shows its fitness to govern itself, instead of being indefinitely governed, regulated, ma-

nipulated, oppressed. It is thus only that the government of the majority is sincere and stable. It is on this basis alone that the supremacy of the law can be founded as on a rock. We are seeking in our country now, with an anxiety that I can understand and participate, some means of placing society beyond the reach of *coups-de-main* of minorities, contemptible for their composition, their quality, or their number. I conceive that it is by this public spirit alone, so conspicuous here, that man can be converted into a political animal, as they call it here, — a being, as Aristotle observed, eminently fitted for social life. It is this alone, in fact, which can give society indestructible cohesion. It is this alone which can impart to the majority a magical energy, both when it is necessary to act and to resist surprise, and when it is necessary to drive back oppression whencesoever it may proceed, whether from a body of insurgents, or from the constituted depositaries of power. So long as we shall not have acquired this fine attribute of the Anglo-Saxon race, we must expect to be the sport of endless revolutions. Nothing will save us, not even tyranny, which reckons, however, amongst us, many secret partisans, — so many admirers who, in the bottom of their hearts, have erected to it a shrine. Tyranny even, with troops of spies and myriads of bayonets, does not offer a safe asylum against the audacious attempts of minorities, however small. The smallest minorities, in truth, have against the best supported tyranny the resource of conspiracies, which, under favour of the very habits engendered by tyranny itself, may have the most signal success. I will not remind those who doubt this of the innumerable catastrophes which in imperial Rome, or at Constantinople, have deluged with blood or defiled the throne of the Cæsars. I will not speak of the cruel end of Paul I. I will mention only the name of Mallet, who attacked the power of the greatest man of modern times.

If the Universal Exhibition, then, had taken place anywhere but in England, it would have been deficient in the great political and social lesson which springs from the manner in which it has been organised; it would have been deficient also in a marvellous monument of human industry. You already know the almost romantic story of the building in which the Exhibition is established, since it is only a few days ago that a celebrated popular writer has related it in your columns, bestowing well-merited encomiums on the architect of the "Crystal Palace."

I will not trouble you with the technical description of this edifice of iron and glass, engravings of which have been already circulated in profusion over the four quarters of the globe. There is but one opinion upon the merits of this construction. It is elegant, simple, imposing, and convenient; it is inundated with light, and easy of approach. Every contingency has been provided against; rain cannot penetrate, nor fire destroy. Steam was necessary to put in motion the numerous engines and machinery established in the mechanical division, for it was thought better to enable the public to see the machinery in motion: there are pipes which distribute the steam where it is wanted, and vast boilers have been erected in an adjacent building, which afford an abundant and constant supply. Water was required for setting in motion some hydraulic engines: means are provided for its distribution. An electric telegraph is there to convey each moment to a central bureau all the communications that may be desired. It is as spacious as a palace twice the length of Versailles. Nothing can afford an idea of it, either as to its dimensions, style, the disposition of its parts with reference to each other, nor the infinite number of small and separate pieces necessary to its construction. In truth, these pieces may be reduced to two classes, a column and

a panel in three compartments. When one reflects that all this has been conceived, adopted, moulded, cast, adjusted, placed, and covered with glass in the space of a few months, we fancy ourselves to be in fairy-land. The Crystal Palace would have been an impossibility elsewhere than in England. It is an evidence of what the industry in iron can effect here, the power of the means it possesses, and the degree of economy to which the fabrication of this material, the most indispensable of all to the arts, has been carried. About a century since the English industry in iron was very unimportant; it was only manufactured with charcoal, a mode of fabrication still obstinately persevered in, to a great extent, in France. England then made about 17,000 tons of iron in pigs. At the close of the last century it was still only 150,000 tons, its manufacture by pit-coal not having yet been well established. She imported then about 40,000 tons of wrought iron. In 1806, the manufacture increased to 258,000 tons; in 1825, it was more than double, amounting to 581,000 tons. When railways came generally into use, in 1835, the iron made was 1,000,000 tons. In 1847 it was double, and now it is about 2,200,000 tons. This is much more than all the rest of the world together produces. It is true that much of it is exported. The exportation in 1849 was 700,000 tons. A certain quantity is still however imported, particularly Swedish iron for making steel, an article for which the iron of Sweden is incomparable. The importation for several years has been from 25,000 to 30,000 tons of wrought iron, which is equivalent to about 35,000 or 42,000 tons of pig iron.

But under what auspices has occurred this great increase of manufacture? Under the auspices of a power which increases as by enchantment consumption, and provokes incessantly the improvement of all manufactures — under the

auspices of low prices. Formerly English iron was dear, even when fabricated by coal; the iron, No. 1., which requires to go through a second process before it can be employed even for the most common uses, was sold at an average of nearly 18*l.* a ton. In 1822 and 1823 it had fallen to half this price; its present price is from 5*l.* to 6*l.* As to pig iron, it has fallen in the same proportion. In the great Glasgow market it is not worth more than 2*l.* 10*s.* a ton. Until 1840, it was hardly ever quoted at less than 4*l.* At the commencement of the century it was quite otherwise. Under the influence of causes on which I need not enter, a like phenomenon was manifested for the other material of which the building is composed, glass. Glass has materially fallen in price in England within the last ten years, and the consumption has much increased. The augmentation even of the consumption, as in the case of iron, reacted on the manufacture, and introduced marked improvement.

This accounts for the fact, that when Mr. Paxton sent in his plan of a building in iron and glass, no fears were entertained either as to the cost or the practicability of completing the building within the required time. The cast-iron used, ready for fixing, cost about 5*l.* 5*s.* per ton. In France, at this moment, at a period when prices are exceptionally low, it costs more than double, and that is one of the reasons for which we have always constructed, for our Exhibition, provisional buildings in lath and plaster, low, ill-ventilated, imperfectly lighted, whatever may be the talent of the architect, and very expensive in consequence of the necessity of being demolished after having served their purpose.

But it was not only the economy of money which was important here, the economy of time was still more so; this latter was absolute. It is again low prices which have procured this. When an ordinary article is cheap, solely be-

cause there is a large consumption, the number of workmen who excel in the art is considerable. Here, therefore, one had only to make a sign, to bring together a multitude of able workmen, skilful in preparing, finishing, and placing the columns and the iron frames, and glazing the building. It was thus that in three or four months the building was completed. Anywhere else, even with the best intentions, it would have taken more than a year.

A cheap market is a great magician. When a nation has obtained one, it possesses the lamp of Aladdin, by which, in the twinkling of an eye, it accomplishes miracles, and it is available for other purposes besides the erection of prodigies like the Crystal Palace. It has contributed not a little to furnish England with the means of passing, without crisis, through a period in which most other people encountered the formidable spirit of revolution. I have already pointed out to you an attribute of the English character that I consider as the moral foundation of the stability of their institutions; a cheap market is now the material foundation of it. Let us not cease to recommend it at home. A cheap market for raw materials, a cheap market for useful products, is indispensable to us. Abundance of work and cheap living — nothing is more worthy of the active solicitude of those who love their country.

LETTER II.

THE WEST AND THE EAST.

You know the basilicas in which the tribunals sat under the Roman Empire, which the Christians converted into places of worship, and after which they built others, when they had acquired the possession of them. They were large buildings, long, airy, surrounded with galleries, and covered with roofs in carpentry. Such is nearly, in its general appearance, the edifice of the Exhibition. It consists principally of one long nave, of 1850 feet in length, 72 feet wide, and 64 feet high. On the right and left extend throughout its entire length, in the form of galleries, very spacious aisles, having two floors, giving the building a total width of nearly 420 feet on the ground floor. The superficies covered is thus about 20 acres. In our Exhibition it was not quite 7; and again, to the 20 acres it is fair to add the extent of the flooring of the galleries. It is, properly speaking, in the galleries that the whole Exhibition is held. In the middle of the length of the nave, to give more solidity to the structure, a transept has been judiciously placed; it is a nave at right angles with the first, but more elevated; it is 105 feet high, and the roof which covers it, instead of being flat, describes a graceful semicircle. Two of the secular trees of Hyde Park, which it was not thought fit to remove, display, under this transept, their imposing forms, and those large masses of verdure which are more common to the trees of this country than to ours. In this construction of iron, where light pours itself in torrents through a glazed roof extremely well constructed, every nation has its assigned space, and the allotment has

been very simple. To each has been assigned a space in the longitudinal nave, proportional to the quantity of the products to be exhibited, with all the depth right and left of the nave, leaving it to divide this space amongst its exhibitors. It is understood that little encroachment is to be made on the nave. This, therefore, forms a grand avenue, serving as a promenade, in which there is a free and uninterrupted circulation of air up to the roof, where it escapes by a great number of openings. The only objects placed in this avenue, at intervals following the axis of the nave, are productions of art, statues in bronze, zinc, and iron, and trophies, or "faisceaux," artistically grouped, of articles of "luxe," or of exceptional dimensions, such as a French organ; a vast frame, in which are splendid specimens of painted glass for a church, from Austria; an enormous mass of zinc ore from the United States; a Fresnel light-house; and a block of English alum, as high as a tower. A sample of native silver, from Chili, and the magnificent telescope made for Lord Rosse, the President of the Royal Society of London, for his observatory, are also placed here. As if to combine agreeable "souvenirs" with this display of objects, some "sévères," others "éclatans," almost all imposing by their mass, in this middle avenue has been placed a monstrous oil-jar of the most primitive pottery, which bears inscribed on it the name of the village of Toboso, rendered celebrated by the amours of the Knight of the rueful countenance; it is from thence it came. There are also fountains, with their *jets d'eau* and basins, from which a pure and abundant stream is continually flowing. Some are in stone, some in marble, some in iron, one, amongst others, by M. André, of the Val d'Osue, one of our most skilful founders, whom a premature death has lately torn from French industry. There is one remarkable for its

height (about 26 feet), elegant and effective, composed entirely of flint glass, from the works of Messrs. Osler, of Birmingham.

Amongst the curiosities thus distributed along the nave, and which are filled with hosts of visitors, the incomparable diamond Koh-i-noor, or the Mountain of Light, a recent spoil taken in India and brought from thence, worth a million sterling, — two millions, — I know not how much, — is pointed out to the curious. In so small a compass it represents probably half the value of all the objects exhibited, and is in nowise eclipsed by them. Placed as it is without any setting, it appears as nothing. It would seem to be designed merely to remind the public, that in the midst of this pomp of industry, wealth alone is a very indifferent title, whatever arrogance it may assume; and that as it is the useful which reigns paramount in this place, it is incumbent on all in our day, more than in any other, to pay a personal tribute of service to society, if they be desirous of obtaining esteem and respect.

A kind of voyage round the world is made when descending this great nave; we enter alternately on the right and left into the lateral galleries. We pass thus in review the principal productions of all nations successively, methodically classed; and by these productions a philosophic observer may, with slight effort, form a pretty accurate idea of their usages, the state of their science, and their manners. It is a peregrination which is not without analogy with that which Homer causes us to make when he leads us through the camp of the Greeks, or with that in which are assembled the people of Asia and Africa, summoned for the defence of Ilium; or when he describes, by the mouth of Helen, the Greek heroes assembled before Troy. One of the impressions which is instantly forced on us by this inspection, is

the difference, or, to speak more correctly, the extreme inequality, between the two civilisations, Western and Eastern. Between the two there is, I was about to say, an abyss; but I will not use this word, for it would imply that fusion is impossible, and that, by consequence, at any given moment the Eastern nations may be reduced to servitude by those of the West, with no other prospect than endless oppression. Now one's whole soul revolts against such a prognostication. Before I proceed, therefore, I must explain the terms I employ.

By Western civilisation I mean that to which we Frenchmen belong, and of which we have been long the leaders. It is composed of Christian nations, has rendered itself mistress of the New World, and has incorporated itself, except in certain spacious regions still desert, the seats of future powerful empires, the embryo of which is now known to the Omniscient alone. It has dominion over all the seas, it peoples with its children all the archipelagos. Throughout the entire globe it commands all the strategic positions. It holds in its vigorous grasp the African continent, which belongs to England on the south, and where France has planted her standard on the north. Asia, so vast, so populous, so varying in its climate and in its productions, is alike nearly enclosed on the southern and northern sides by the English in India, and by Siberia, to which population is attracted by the gold mines. This Western civilisation has now impressed an indelible sentiment of respect and terror upon all the Asiatic people, of whom the most numerous, the most considerable, and the most advanced, lately designated the Western people "the red-haired barbarians."

The Western civilisation, leaving India, has proceeded from east to west by a series of stages; it has marched for-

ward gradually, but haughtily, and without ever making long stoppages anywhere; it has thus come by degrees, first from the confines of the Mediterranean, afterwards to our Atlantic shores; then to the eastern valleys of America, from the mouths of the St. Lawrence to those of La Plata, and to Cape Horn; and it has latterly planted populations full of ardour on the western side of the New World, in California. In the course of this laborious pilgrimage, marked by so many majestic or terrible episodes, it has, from distance to distance, improved the laws and manners, the arts and sciences. With it thus all is transformed, — all, even to religion, which is the "lex suprema," the culminating point of theory, the mistress of ideas and usages; and its industry, in particular, is making continual advances.

Eastern civilisation, less bold, less energetic in its progress, has likewise had extension, but in an inverse direction, proceeding from west to east, and undergoing also great metamorphoses.

It is thus that, issuing from India itself, it has established the empires of China and Japan. It composes a family quite distinct, and which differs from ours as much by its industry as by its genius and its philosophi and religious doctrines. India, China, and Japan, which are the brightest gems of its crown, form more than the numerical majority of the human race.

Between Western civilisation and that of the East, a third is found intervening — it is that of the Mussulman people, a civilisation in which the sap has ceased to ascend for ages. This people, which eight or ten centuries ago was the conservatrix of the sciences and letters when Europe was wrapped in the rude swaddling clothes of the middle ages, is now involved in the most gross ignorance. Formerly it sent to Europe the inventions or productions of the

extreme East, such as the mariner's compass, decimal arithmetic, the culture of the sugar-cane, rice, and cotton; latterly it follows at a distance, and with halting steps, Western civilisation, at the command, or rather under the lash, of some princes of strong will, and of some ministers of intelligence, to whom posterity will award a palm, but who are as much detested as they are little understood by their subjects of to-day.

These three civilisations deserve to be studied separately, at least in their *ensemble* at the Exhibition. They may be recognised at a glance. This is the division of the great East, of China, India, the Asiatic archipelagos. Japan is not found here; it is the effect and the sign of the isolation in which that nation persists in shutting itself up. It is for the future to disclose how long it will be, between the English at Hong-Kong, and the Americans at San Francisco, before the ports of Japan, how strictly guarded soever they may be, will remain without being forced.

In short, the space occupied by this civilisation in the Crystal Palace is very trifling. I have observed a certain quantity of raw materials, but they are only a part of what she might display, and the same observation will apply to alimentary substances. As to fabricated objects, its contingent, at least as relates to China, is not nearly so great as it might be; still there is enough, not to give an accurate idea of all the raw materials this people produces, nor of the materials they employ, but to form some opinion of their power in the world, and of their general aptitude to procure for themselves the principal elements of well-being.

When we have made a tour of the Crystal Palace, we are struck with the general character which distinguishes the industry of the Western and Eastern people.

The Chinese is extremely adroit with his hands. What

he makes with his ten supple and nimble fingers, with some bits of bamboo and twine, is surprising, incredible. The Hindoo, more limited in his industry than the Chinese, shows, in several of the branches which he cultivates, manual address not less marvellous, to which is often united extraordinary taste. Angels obliged to use the same expedients, could not do better than these two types of the East. As to us Western people, if we were reduced to such a necessity, we should fall to the last degree of awkwardness and impotency, and consequently of misery. Yes! but we have other appliances. It is not our fingers which are our best machines.

We have seized Nature herself with an iron grasp, and with fingers of steel. By the power of our minds, by our indefatigable perseverance, by the analysis we make, as with a sharp axe which nothing can resist, we have brought her under our dominion; we constrain her, from day to day, to reveal her secrets, to deliver to us some one of the powers that she retained hidden in her bosom, and to labour for us. In industry, in this day, everywhere, except in the domain of Western civilisation, man is a slave overpowered by labour; but in the West he is no longer a labourer; according to the observation of one of our prelates, he is the foreman who superintends, or each day he is becoming so. This is the origin of the power now possessed by Western civilisation, of that immense superiority exhibited so strikingly in the Exhibition of London, but which has only been definitely acquired in modern times. This group of nations surpasses the rest of the human race in industry as much as they excel them in war, because nature is their slave, and yields submissively the concurrence of its power. Currents of air and streams of water are at their command. In the bowels of the earth, often at fearful depths, under the guard of an invisible

dragon, more formidable than the monster of fable, "le grisou," there are masses of coal, relic of a luxuriant vegetation, which dates back for thousands of ages; they descend in search of it spite of all obstacles; they create heat, that is, power, which develops in the substances submitted to its action a multitude of other forces; they create steam, and steam is power. The chemical attractions, electricity stationary and in motion, heat and cold, the light of day and the darkness of night, the weight of solids, of liquids, and of gaseous fluids, tenacity, elasticity, capillary affinities, — all which is force, in fine, acknowledge the law of the Western people, or will submit to it hereafter, partially or altogether: for this Western civilisation does not retrograde; it marches everywhere and in every direction; it has never said its last word; obstacles only serve to fill it with new ardour. Before its day, the sea was an impassable barrier. How palpitated the heart, said Horace, of him who first adventured on the placid bosom of the Mediterranean. Now the sea is for it a commodious and economical means of transit, and it is an insular people, circumscribed by the sea, the same which the prince of Latin poets depicted eighteen hundred years ago as absolutely shut out from the rest of mankind, who now have the most extensive relations with every point of the globe. Disregarding the mountains with their steep summits, their precipices, and their eternal snows, it pierces them from side to side. To supply its power with engines worthy of it, and proportioned to the forces and to the natural agents which it uses, metal in abundance was necessary, and, above all, iron in boundless quantity. This it would go in quest of to the very centre of the globe, if it suspected the existence of a more productive mine there. By means of the obedient auxiliaries that it employs, it would arrive even at such a vein despite of the thickness of the rocks and of subterranean

currents, and it would tear the metal, if necessary, from the most intricate and complex combinations.

This sign of the abundance of iron in Western civilisation, is to be remarked as a characteristic trait. The Roman empire, at the height of its grandeur and power, did not produce probably the fourth, or perhaps the tenth, of what is now made in France, and England produces four or five times as much as our country. It is now nearly two thousand years since a poet said of Western civilisation, designating it by the name of his father Japhet, "Boldness is its name;" but it is, most frequently at least, boldness resolute and calm,—boldness which does not tire, and for which a conquest is but an instrument of a new acquisition,—boldness worthy of empire, because it remains mistress of itself.

Our Western civilisation, like the magicians of the Arabian Nights, which have genii at their service, disposes then of innumerable powers, always more varied, and always increasing in intensity and docility. It is in this wise that it has established its pre-eminence in industry, and that it strengthens it incessantly: for, be it observed, all industrial questions are questions of power. Man has not here below the power of creating an atom of matter, although in his pride he arrogates to himself the quality of creator. All that is permitted us to accomplish is to put matter in motion. We transport bodies, we displace their molecules, we separate or bring them in nearer approximation, we divide or combine them. The better to transport, to displace with more success, to separate or combine more rapidly or more easily, include all the progress of industry. It is thus that is solved better and better amongst us, the problem of the abundance of products of all kinds; or, if you prefer another formula, more striking and more human, that of providing for our wants at the lowest cost, which in our day ought incessantly to occupy the

attention of every one who aspires to the title of statesman, and who would contribute to the prosperity and well-being of society.

The most striking differences, which so clearly distinguish the industry of the Western nations from that of the Eastern, follow from what has been above stated. We have infinitely more power of transforming the raw materials than the Eastern nations, because we have appropriated infinitely more physical resources of every kind. Howsoever ingenious they may be in their operations, how cunning soever of finger craft, they cannot bring the objects on which they bestow their labour so far from the natural state in which the soil delivers them to the agriculturist, or the bowels of the earth to the miner, as we can; the forces which are at their disposition being incomparably less than those that we command. Taste they may possess, for the Hindoos are infinitely endowed with it, to imagine forms of elegance, such as are observed in their vases, graceful designs and harmonious combinations of colours, as in their shawls, their scarves, and even in their carpets; but, wanting power, they can but apply this taste to a small number of substances, to those which are most easy of manual fabrication. In vain do they possess a very remarkable genius for invention, they have insuperable difficulties in carrying to perfection their first ideas; the most powerful means of action that exist, the great forces of nature, escape their control. For the same reason, large production, that is, that which accomplishes much work with few hands, and furnishes a great quantity of divers products to supply the ordinary necessities of man, is interdicted to them in nearly all branches of industry.

Let us cite an example of the extent of the advantage that we Western people owe to all these subjugated powers. It has been calculated, and this calculation does not appear

to me an exaggeration, that to produce by the Indian method, that is, by the dexterity of the fingers and the power of the arms, all that is now done in England alone in cotton, threads, and tissues, two hundred millions of persons, being good workmen, would be insufficient. Two hundred millions of persons! It is nearly the half of the efficient portion of the whole human race, both sexes included; it is from one hundred to two hundred times the number of operatives of the factories of cotton thread and tissues in Great Britain.

When a nation is in its industry deprived of the assistance of the powers of nature, so precious and so liberally supplied to us Western people, it must necessarily happen that it will possess an extremely small share of all products the fabrication of which requires a certain amount of force. Such a nation is, therefore, comparatively doomed to poverty, and its people must live under severe privations; or, if certain articles of consumption exist in abundance amongst them, we may take for granted that they result from an exceptional liberality of nature, which requires but little effort on their part to render them available. It is thus that, in India and China, the population have a resource of easily providing for their subsistence by rice, because, by the favour of heaven, their climate and their soil are miraculously adapted to its culture; but as to the greater part of manufactured products, requiring the systematic employment of power, they are but miserably provided in comparison with the Western nations.

So long as they continue the means which now serve as the basis of their industry, the greater number of them will remain devoted to irremediable misery. On the contrary, the people of the Western civilisation have industrial resources which allow them to hope for the well-being of all their children, under certain conditions, which have relation

to moral rather than industrial order. These are the love of industry, temperance, respect of property, the spirit of liberty and reciprocal justice.

I shall have to enter less summarily into a consideration of the industry of these two groups of people for the Western civilisation especially; to speak of their respective merits, and to point out, at least in a general manner, what is Mahometan industry and civilisation.

LETTER III.

MUSSULMAN CIVILISATION.

After the generalities of the preceding letter on the fundamental differences which exist between the industry of Western civilisation, the members of which are the different Christian people, and that of Eastern civilisation, which has for its principal representatives the Hindoo people, China, and Japan, we will notice Mahometan civilisation, under which are comprised so many millions of men, placed, as it were, by Providence, as intermediate agents between the Western countries and the great East, and which has given them a peculiar character and importance.

In industry, Mahometan civilisation ranks the lowest of the three in the scale. It is matter of surprise that these nations, which have had so much influence during certain epochs, which have caused both the West and East to tremble, have not attained a higher perfection in the useful arts. The Arabs, amongst whom Islamism had its birth, and who have continued its purest representatives, were powerful at a period when the useful arts had not as yet received in any country a strong impulsion. In the days of their splendour,

they manufactured all that the science and art of the era allowed. The productions which the celebrated Caliph Haroun-al-Raschid sent to Charlemagne, were deemed wondrous by the Western people. The marvels of industry were still, however, unrevealed. The science of manufacture, or, in other words, gigantic establishments, organised on the principle of the division of labour, which, according to the profound observations of Adam Smith, is eminently favourable to improvement in the arts, and to their abundant and economic production, which in effect are its essential condition, were unknown. The power of the Arabs was, moreover, but of short duration. It would seem that Providence only allowed them to become great, that they might be the guardians and preservers of human knowledge while the West was involved in the darkness of the middle ages. Hardly had they relinquished their trust to the re-enlightened Western nations, than they declined.

Succeeding them, Islamism had for its apparent head and arbiters tribes still more formidable in war, whose especial genius rendered them more skilful in exercising and retaining authority, who planted the standard of the Prophet in lands far east and west, but whose policy excluded the arts of peace. We may form some opinion of them by the Turks, who, of all the people springing from these warlike tribes, are those with whom we Western nations are best acquainted, who have established their power on the most solid basis, and who alone still maintain a certain consideration in the world. The Turks would not be, or knew not how to be, other than conquerors, and it is on this account that Montesquieu has said, with reason, that they were encamped in Europe. Amongst them the pursuit of the useful arts is the lot of rayas; and as between the Turk and the raya there is the infinite distance assigned by an

intolerant religion, industry is as dishonourable for a Turk as commerce was for a patrician of Rome. The rayas, the producers of wealth, have been pillaged, and allowed to be pillaged, because pillage is an easy mode of obtaining wealth, and because it was thought that the more miserable they were rendered, so much the more dependent would they be. In all the countries submitted to Mahometan authority, until within a few years that the spirit of equity has exhibited itself in the Turkish empire, the mass of the people have been, for a succession of ages, constantly and systematically harassed, oppressed, and plundered. A population continually decreasing, they exist miserably, even on the most fertile soil. Where liberty is unknown, and where might becomes right, industry is impossible; nothing is possible; not more that which procures the physical well-being of man, than that which elevates his morality.

It is worthy of remark, also, that the Semitic populations, over whom the Turks had placed themselves, appear to possess, in a very low degree, the faculty of invention in the useful arts. The Arabs excel, it is said, in composing legends. This same people invent so prodigiously in history, that, amongst their writers, truth is undistinguishable from fiction; but in industrial matters, this rich imagination is unproductive. In this respect they are very inferior to the Chinese, who are indeed a very inventive people. I cannot call to memory any new process, any invention of an industrial tendency, which can positively be attributed to the Arabs. The Damascus steel was obtained by a method brought from, and still practised in, India, represented in the fine collection of the products of their mineral empire, which the East India Company has sent to the Exhibition, by several maces and other articles. The figures called Arabic, with that ingenious rule of position which consists in attributing to them a value

increasing decimally to the left, are the invention of the Hindoos, and not of the Arabs. The progressive changes in religious sentiment, which have, in general, for their effect, to modify the lives of men, have made but slight difference in the usages of the Arab population. They who were a pastoral people in the days of idolatry are still so. They live under tents; they prefer clothing made from the fleeces of their herds, like Laban. Their household utensils are of the same date, made of wood or coarse pottery, or of skin rudely prepared. Their "couscoussou" is the cooking apparatus of the Philistines. To give them a taste for, and habits of cleanliness, Mahomet in vain prescribed repeated ablutions; the Arabs, notwithstanding, continue disgustingly dirty. They have adopted the gun and gunpowder but from necessity, since they could not do without them so soon as their neighbours had obtained them. In their articles of luxury they have finished by admitting silk; but not until it had previously been brought by others than themselves from the extreme East to the people of the West. Its introduction was due to two monks, who, under Justinian, in the sixth century, arrived at Constantinople with the precious eggs of the silkworm that they had obtained in China. The culture of cotton is one among the few arts which are, to any extent, due to the Arabs, not that they have introduced any improvement, or that they are the authors of any invention in spinning or weaving, but they extended considerably the culture of this precious plant in the time of their power. They found it in Egypt when they effected the conquest of that country under Omar, and thence they introduced it in their progress throughout the entire surface of the vast continent of Africa. They also brought it into Sicily and Andalusia. They carried with them to Spain, at the same epoch, the sugar-cane, which is Asiatic, and thus contributed to its

passing to the New World, where it was not indigenous; and, in all justice, the fabrication of sugar from the cane, which for many years has been spread through Andalusia owing to the efforts and sacrifices of M. Ramon de la Sagra, must be attributed to them. The Arabs also, about the same time, introduced into the western regions the culture of rice. These benefits conferred on industry deserve to be recorded with gratitude; but none of the arts which are based on the culture of cotton or the sugar-cane, have been remarkable amongst the Mahometan populations. Until these latter times, every art has, without exception, gradually declined amongst them. I doubt if they manufacture any portion of the refined sugar they consume. The cotton which is now cultivated in Egypt, and of which the Exhibition offers some good specimens, is grown there, not from the ancient plantations of the Pharaohs, which the Arabs preserved, but from seed brought from the United States, under the Viceroy, Mehemet Ali. The greater part of the tissues of cotton or silk, of which the Mahometan populations now make use, are not fabricated by themselves. It is to our civilisation, or to Asia, they are obliged to have recourse for the greater part of these articles. It is not they even who imagined the use of tobacco, to which they are so much addicted; it came to them from the western countries, who derived it from the savages of Virginia. It would, however, appear, that they have improved the pipe and the art of smoking. The most decided and most original of their quota to the Exhibition is, indeed, a fine collection of pipes, or "narguilés," which came from Constantinople, and which they have displayed with much taste.

The Mahometan civilisation is represented at the Exhibition by a rather large quantity of objects from Turkey, Egypt, Tunis, and even Algiers. The Turkish division par-

ticularly is prepared with much art. Let us go into the stall reserved for these countries, leaving unnoticed, for the instant, the articles which date from about thirty years. What most strikes our attention? First, a small number of raw materials, principally wool, corn, dates, and honey. We find also the "valonce," and the oleaginous seed of the "sesame," already celebrated in the Arabian Nights' Entertainments, but since celebrated by the history of an amendment voted with us in 1845, with the adjunct of violence towards the ministers on the part of a great number of pretended friends of the government of that day.* In fabricated articles there are woollen tissues with but little variety; "burnous" veils, scarves, thick mantles, covering for cattle and for tents, a complete tent erected, saddles with their accessories, some utensils in iron and wood, and tinned vases. All these things are of the most antique kind, except the silk introduced into some of the stuffs, and the tinning. These woollen tissues are not milled like our cloths, they are not twilled either as our merinos; they are, in fact, the first products of art. I would swear that the scarves, the veils, the girdles, the tissues of wool of a certain fineness for dresses, that I see in different places of this division, are the very fac-simile of the wedding presents of Jacob to Leah or Rachel. The tent that is erected must be the exact copy of that under which the unfortunate Captain of the Host, Sisera, worn out with fatigue, sought an asylum in the desert; and the great nail, the very reproduction of that which Jahel, violating all the rights of hospitality, drove into his head whilst he slept.

* I mean the amendment which bore the name of its author, M. Darblay. On this occasion, many deputies who believed themselves conservatives and supporters of the government, gratified themselves by obliging the ministers to vote publicly against the ministerial project, on a law respecting the customs.

This staff must have beaten Balaam's ass. This basket, hermetically sealed, filled with dates, is, both as to itself and its contents, similar to those that Melchisedek had in his stores. This little leather bottle is exactly like that which Abraham gave, filled with water, to poor Agar, when the jealousy of Sarah caused the patriarch to send her into the desert, leading her son by the hand.

In the Exhibition of these people, still primitive in regard to material life and industry, objects may be seen which seduce at first sight by their "éclat," and which we might readily admit as proofs of progress. These are articles of luxury, particularly saddlery, which are resplendent with gold and red velvet, embroidered over and fringed with gold. This magnificence imposes on the superficial. We pass it, however, without admiration. Gold and silver possess the virtue of pleasing men. Gold, more than silver, is unalterable in its beautiful colour, and in its natural state is extremely easy to work. It is very ductile, very malleable, and is easily soldered. Threads may then be made, without much trouble, which, converted into binding and fringe, singularly relieve the tissues into which they are introduced. A work, then, apparently very beautiful in gold, is but a doubtful evidence of industrial power. There is not a rude civilisation which has not jewels in gold of a certain beauty, on inspection of which unreflecting travellers are in ecstacies. Fernando Cortez, at Mexico, was stupified with the gold and silver articles that he saw in the hands of the envoys of Montezuma. He mentioned them in his letters to the Emperor Charles V. in terms of the most unbounded admiration. And yet the Mexicans were but sorry manufacturers. But I find at the Exposition itself a proof how little importance ought to be attached to works of gold or silver, if they be not works of art, such as are exhibited here in such profusion by the

Froment-Meurices, the Odiots, the Morels, the Mortimers, the Garrards, the Wagners, and many other French, English, German, Belgian, and Dutch artisans. Let us go into the division of the people of Barbary. We are now on the west coast of Africa, amongst the Ashantees, the tribes of the gold and ivory coasts. Look at this gold necklace, and this other piece of jewellery, the form of which reminds one of the brooches which our ladies wear. At a little distance they look well. But look at the articles that surround them —do they not convince you that you are among savages?

If you would form a just idea of the degree of advancement of the industry of a nation, it is not the gold and silver you must look at, it is the iron. Learn if a nation produces or consumes much iron. Look at its tools, its utensils, its machinery; examine what figure iron makes among them. If the consumption of iron is great, — if, which is the same, the tools and utensils in iron are numerous, solid, and good-looking, — if cast-iron, forged iron, or steel is the principal material of the machinery, — if you see that the workmen are adroit and clever at keeping in order these instruments and apparatus, you may then pronounce, with closed eyes, that the nation is advanced, very far advanced, in industry. If, on the contrary, the consumption of iron is very limited, if the iron tools are of sorry make, if in the machinery and apparatus iron is only sparingly used, if it be badly worked, badly finished, they are a nation behindhand, and must be classed in an inferior rank. By patience or dexterity, a few branches of industry may be brought to some perfection among them, but the *ensemble* will be of a low degree. The production of almost every article will be limited in proportion to its own population, and from that cause will the country be poor; it will be poor, because the production is necessarily limited when

there are but bad tools and bad machinery, or when, for want of good materials, machinery cannot be constructed; and when the production is limited, there can be but few products for each, — the population is miserable.

This being settled, let us return to the articles of Egypt, of Turkey, of Tunis, and of Algiers. These saddles, resplendent with gold, have seduced you; raise the outer leather, examine the buckles, the rings, all the parts in iron, they are rude; the bits and spurs are no better; the buckles are faulty both in make and shape; the rings are not round or oval; the surfaces are rough and the soldered parts unsound, the thicknesses unequal. Go to the tools. Look at the horse-shoes, — how ill-fashioned! how ill adjusted! In the machinery it is the same, it is coarse in every respect. All these defects arise from their having but little iron, and not knowing how to work it. It is replaced, as far as possible, by wood. Look, for instance, at the Tunisian exhibition, which, however, in many respects, is very interesting; this tool with the blade bent, so thin and weak, it is, I should think, a sickle to cut wheat. It is a miserable affair; the reaper who has to use it must be worn out with very little work. But when iron is very scarce, what is to be done? A little further on look at the lock, which is from another part of Africa. It is completely of wood. The ticket on it informs you that it is of the same pattern as in the time of the Pharaohs, — an interesting notice for the antiquary, but rather afflicting for those who love the progress of the arts, as being a certain pledge of the amelioration of the condition of man.

That the evidence of the backward state of industry amongst the Mahometan populations may be more complete, take a "coup d'œil" of their machinery in another point of view, examine to what it is applied. You see hand-mills. You need go no further, the cause is obvious. What! corn

still ground by manual labour in these countries! They have not yet made sufficient advance to liberate the human race from this distressing labour, that caused the slaves of old to send forth groans, of which all the poets of antiquity, from Homer in the Odyssey, to those at the fall of the Roman empire, have preserved to our day the painful echos! The weakest portion of society, the women, are engaged amongst the Arabs, as they were in the house of Ulysses, in this drudgery; so much so, that even in the invasion of Algiers the French were welcomed because they had introduced water-mills. Such a civilisation and industry require no comment.

In the Exhibition of the Mussulman people, there are several articles of considerable number which have an impress varying from the rest, and in which the hand of Europe may be distinguished. Such are the tissues of cotton or milled wool, such are metals tolerably manipulated. The origin of these articles is well known. The governments of Egypt and Tunis are struggling to shake off the yoke of secular discipline. They have attracted French, English, and Italian engineers, who have established various machines and apparatus, and founded workshops of different kinds. It is thus that in Egypt, during several years, cotton has been manufactured on a great scale, after the manner of Manchester, Rouen, Neufchatel in Switzerland, and Saxony. The Bey of Tunis has also established several manufactures. Have these attempts at progress been always well understood? This may be matter of doubt. The manufactories of tissues have probably been, for instance, too much multiplied.

These countries, so far behind others, would probably have found better results, if at present they had more particularly directed their attention to the production of raw materials. The abundance of fertile lands which they have at command, would have rendered their labour very profit-

able, and they might then, by means of barter with Europe, have procured manufactured articles, with the same labour and the same capital, in greater abundance than by direct fabrication. It is incontestable, however, that the transport of machinery and the methods of Western civilisation into the Levant, is, apart from the errors which may affect their application, worthy of all encouragement and praise. The processes of the Western nations, their machines, their tools, and their utensils, have an immense superiority. The division of labour which they employ, and which is incessantly increasing, is a source of wealth. The dominion over the forces of nature, of which they give the example and the secret, increases a hundred-fold the productive capability of man. In fine, whatever motives one may assign to them, the Mahometan governments which exert themselves for the introduction of the practices of Western industry, are the benefactors of their subjects.

LETTER IV.

EUROPE.

WE must now advert to the position which the group of nations that I have designated under the collective title of "Western Civilisation," holds in the Crystal Palace, — it is the "ensemble" of the Christian nations, it is Europe and America, in addition to the bodies of Europeans who have spread themselves in the other parts of the world, and which are found at the Cape of Good Hope, in Australia, Java, and the twenty other archipelagos. It is in them that resides now incontestably the power of the human race. They are visibly invested with the empire of the present, and are the depo-

sitaries of the destinies of the future. They prevail much less by military force, which has furnished to them the apparent means of subjugating the rest of the world, or of inspiring it with a salutary fear, than by the sciences and letters, and by the useful and fine arts. They prevail more especially by the grandeur of their sentiments, the nobleness and extent of their sympathies. They alone, at least the more enlightened of them, have the conviction, profound and henceforward practical, that men, according to the will of God, are destined one day to constitute here below, by the progress of human institutions, a single family, and this is the foundation of their religious faith. This Exhibition itself supplies at present a proof of the bringing closer together of all the nations which compose it, of the feeling which unites them one to another, of the conviction which they have of the unity of their interests, and of the desire which animates them to act in concert and assist each other.

It is the moral superiority of this race of men, and that alone, which is the origin and justification of the supremacy they have acquired on the earth, and which is every day more and more consolidated.

The London Exhibition is an industrial tournament of this group of nations; it is among them, almost exclusively, that the jury will have to distribute the rewards, pledges of superiority, and to proclaim the victors. The other nations can only obtain honorary distinctions, and it is certain that they will be freely bestowed. Certain conditions are wanting at this competition, that it may have all its importance. Some of the Western nations could not be properly represented; with others the principals of several branches of industry would not. Thus, by the effect of a misconception as to the ultimate period allowed for sending their products, the two kingdoms of the Scandinavian peninsula have in the

Palace of the Exhibition only a very limited and insufficient representation of their skill, and particularly of their irons, the quality of which is, up to this moment, incomparable for the fabrication of steel. The usual delay of the opening of the navigation of the Baltic, had hitherto prevented Russia from being present, although in a few days her division will be open for public inspection. It is said that the Neapolitan government has refused to allow its subjects to participate in the Exhibition. The truth is, that I have sought in vain for the products of the very fertile soil of the Two Sicilies.

In the United States, it would appear that the chief portion of the principals of industry have shown very little favour to the enterprise. Brother Jonathan has pouted at John Bull. The large space assigned to this nation, so enterprising, so active, so ingenious, is very imperfectly filled. In a certain number of other states there has been partially some of this ill feeling. Thus, in Spain, the manufacturers of Catalonia, who are the principal of the Peninsula, have almost with one common assent abstained.

In France, the glass manufactures of Baccarat and St. Louis, than which nothing is superior in the world, were not sent by the manufacturers; the same was the case with the glasses of St. Gobin and St. Quirin, which are at the head of their art.* It would not, however, have occasioned much trouble to show samples of these products in the Crystal Palace, for they have a depôt at London. Our iron-masters in a body, with the exception of the proprietors of Bruniquel (Tarn et Garonne), and M. Baudry of Athis-Mons (Seine et Oise), and the greater number of our engineers (constructors) have followed this sad example. The house of Cail, of Paris,

* At the end of the Exhibition, the beautiful productions of these establishments were exhibited in the Crystal Palace.

of André Kæchlin, of Mulhouse, and some others, however, have worthily sustained the honour of French machinery. In our tissues of wool, also, there were lamentable deficiencies. Our makers of chemical products, also, omitted to answer the appeal. Several of our most justly renowned linen manufacturers, also, remained shut up in their tents, immovable as the angry Achilles, instead of appearing in the lists, where victory awaited them. In fine, however, without displaying its products as freely as England, who was at home, all the manufacturing nations of Europe have articles at London, which will allow a just appreciation to be formed of them.

When we have inspected, in the Palace of the Exhibition, the different productions of Western civilisation, we are voluntarily, or by compulsion, impressed with the idea that all these different people have in the main the same genius. If chance cause you successively, and at short intervals, to traverse the salons of Paris, London, Berlin, Vienna, St. Petersburgh, Rome, — I may also mention those of Dresden, Munich, Turin, Stockholm, and Madrid,—a similar reflection will occur to you: you will perceive that it is the same family; it is, in effect, the same circle of ideas and sentiments; and the conclusion of your tour would be, that you imagined that you had only passed from one quarter to another of the same town, or at most from one province of the same state to another. To complete the illusion, the same costume precisely is worn, often made from the same piece of cloth, or velvet, or lace, and made by the same tailor or "modiste." That some differences are visible is incontestable; but they are of the same order as may be met with everywhere among relations, and then this reflection presents itself to the mind :—How has it happened, that in bygone times, nay, even within half a century, there has been amongst these people such deadly hatred, and how is it they have mutually destroyed each

other like beasts of prey? Happily, it may be hoped that such times are passed, not again to return. It was the last dying throe of the "ancien régime," a fearful dying effort, but now that *régime* is no more. A feeling of universal fraternity had its germ formerly in Western civilisation; it has been developed little by little, and has in our day acquired considerable extension. By the effect of the great movement, the signal of which was given in 1789, and which has since pursued its irresistible course, it has, spite of the terrible episode of a twenty years' war, overpowered the exclusive interests of some classes which were based on the division of nations. They who would endeavour to renew these divisions, would be madmen; their madness, however, would be criminal, without being dangerous. Western civilisation forms a great community, whose desires all tend to its increase. Its doctrines, as its interests, cement this union.

The state of industry amongst the nations of the West reveals this "rapprochement" in a striking manner. Everywhere, in fact, amongst these nations, there are found the same apparatus and the same processes, derived from the same theories. In industry now no mystery is possible between our European nations. We have reciprocally the key of our industrial operations, alike to that of our political combinations, inasmuch as we move in the same sphere of sentiments and ideas.

All that a German or a Frenchman can perform in industry, the English will not be tardy in accomplishing if they please. Should an invention be announced in Lancashire, or the far end of Scotland, the French, Germans, or Americans, by applying their attention to it, will soon discover it. This is apparent every day in all kinds of inventions. As Mr. Nasmyth, an Englishman, and M. Bourdon, a Frenchman, each claims to be the inventor of the forge-hammer, so

twenty tinctorial drugs, and fifty chemical processes, have given rise to similar controversies. So, in the pure sciences, the glory of having first promulgated a great or inferior idea is frequently contested. By a method which confers on him the greatest honour, M. Leverrier discovers a new planet; no sooner is this done than an Englishman appears, who proves that he has been engaged on it also successfully; and whilst on either side the question of precedence is in dispute, forth comes an American astronomer, who claims to be the real discoverer, and who produces evidence of his claims. A problem resolved in the north, is no sooner known to have been so, than it has its solution at some other of the cardinal points, if indeed it have it not already. Proof of all this is supplied by the law-suits for priority of discovery in patents for inventions. Almost always some foreign document is produced, which proves the simultaneousness of the invention, and probably in two or three places at once. To acquire by the power of our science, very superior though it be, the secrets of the Hindoo or the Chinese, is less easy than to discover those of Europeans, because the similarity of ideas, the turn of mind, is the same between the Western people, but different from the other.

The forty years which have elapsed since 1815, have largely contributed to this industrial unity in Europe, and to Western civilisation. The people, relieved from the harassing effect of war, gave themselves up with ardour to peaceful industry. They cultivated assiduously and with success the application of the sciences to the industrial arts, and amidst these pacific labours, not only the bitter sentiments of hatred which they acquired on fields of battle were effaced, but the inequalities and discordances arising from their industrial pursuits rapidly softened down. They have exchanged their ideas and communicated their processes. There has been a

mutual instruction, which has raised the humble and strengthened the weak. Each one has endeavoured to acquire what he has observed salient or remarkable amongst others, and always with success, at least amongst the most remarkable of the nations. Thus we supply the English with articles with which, thirty years ago, they considered themselves exclusively privileged to supply the whole world, such as certain kinds of woollen thread, and certain handsome printed stuffs; we have even sometimes sent them small articles of hardware. The European governments, with the view of facilitating such commercial interchanges, have displayed a good-will, which, if it be not always enlightened, does not the less entitle them to public gratitude. At this moment each of the great states of Europe has appropriated to itself, to a surprising extent, the practice of all the important branches of industry. Each of them has formed a mass of intelligent workmen, well skilled in practice, as well foremen as others; each has produced or procured machinery and tools for all sorts of manufactures, on the same pattern, often from the very same workshops. The English alone, for some time, furnished the whole world with machines for spinning cotton, flax, and wool, and steam-engines. Now, at Barcelona, numerous looms of André Kæchlin, or of Schlumberger, spin cotton. The workshops of our railway companies, as well as those of the English and German companies, have the machine-tools of Whitworth of Manchester, amongst which connoisseurs particularly admire the radial machine at the Exhibition, or those of Nasmyth.

The house of Cail furnishes almost all Europe with machines for the manufacture of sugar, as it is our engineer Chapelle who has made and sent in all directions the most perfect apparatus for making endless paper. This harmonious development of means of action, as well in the "personnel"

as in the "materiel," which necessarily brings similitude of products, is striking, particularly for the three people amongst whom the movement of thought is the most active, the most energetic, and the most free, that is, the French, the English, the German, and some small states, such as Switzerland, Belgium, Holland, Piedmont, who, while enjoying political independence, are not less, in respect of industrial pursuits, satellites, firmly bound to these three great leaders.

The double similitude I point out is not contestable, as to the methods and processes of production, to whomsoever has visited the workshops; it is not more so as to the kind and merit of the products, since on neutral markets, and in the small places which now form the narrow domain of liberty of commerce, — I would say in the *entrepôts*, — you find them opposing one another, and selling by competition the manufactured products of the five or six states I have named.

The industrial unity among the nations of Western civilisation is again manifest from the circumstance that in the greatest number of cases now, the processes themselves are due to concert, direct or indirect, apparent or latent, of men of all nations.

The first idea of a machine or a manufacturing expedient shall be suggested at Paris or London. It receives its first improvement in some obscure village in Thuringia, and it takes a practical shape for the first time at Manchester or Sheffield; then, by various transfigurations, not less curious than that of Vishnou, it re-appears successively, always improved, in the *ateliers* of Lyons or Zurich, or in those of Breslau or Verviers, Elberfeld or Glasgow. Nor can we be certain that it will not be on the other side of the Atlantic, at Lowell, or still further, at Pittsburg on the Ohio, that it will arrive at perfection. We have had already examples of similar facts some time since. Margraff produced, in some

corner of Germany, specimens of beet-root sugar; Achard attempted to establish a manufactory of it at Berlin; and it was from thence that the idea passed into France, where it became the manufacture now well known.

A French engineer, Lebon, conceived gas-lighting; his idea passed the Channel, and it was in England that it had that prodigious success by which the whole world now profits.

The Emperor Napoleon, with a view of ruining English industry by the substitution of flax for cotton, offered a premium of 40,000*l.* to whoever should solve the problem of spinning flax by machinery. A Frenchman, M. Philippe de Girard, set to work, and before 1814 succeeded. After the peace he established himself at Warsaw, where he nearly brought his idea to perfection. From Warsaw his idea travelled to Leeds, where Mr. Marshall perfected it, and laid the foundation of a great manufacture, which soon enriched that same England whose ruin its promoter had proposed. Every year sees brought forth some improvement or some new application of the machine invented by our celebrated Jacquart, and by which so many results favourable to low prices have been attained, without adverting to the number of children which it has emancipated from drudgery. The last year, at Nottingham, it has been applied to embroider net, whence has arisen an industry that has enriched the whole town, whilst it is spreading throughout England and the Continent.

This industrial co-operation of nations is now the daily bread of Western civilisation. I say the daily bread, for it contributes much to promote the general amount of labour, and to enrich each particular nation.

The same product receives, or may receive, a first fashioning amongst one people, a second amongst another, a third from another, and so on. It traverses thus five or six frontiers,

and is elaborated five or six times before it arrives at the hands of the merchant, who sends it far or near, in his own town or in the other hemisphere. Here is some muslin, that perhaps has been woven in Saxony, with thread from Manchester, obtained from a quantity of cottons grown at Surat in India, at Mobile in the United States, or in Egypt; it will go to Nancy to be embroidered, to be sold at Philadelphia, Canton, or Batavia, after having passed through the warehouses of New York, Hong-Kong, or Singapore.

The Crystal Palace is a good place to verify this similitude, this fraternity, this equality of industry among the principal people of the Western civilisation. It is evident there, it is glaring to the eye. I pass from the English department to the French, thence to that of the Zollverein, or Switzerland, or Belgium, or Holland. I find over again objects of nearly equal merit, which attest nearly the same aptitude, the same experience, the same acquirement. This is more particularly obvious with regard to England and France, especially if we take care to complete our exhibition at London by the recollection of the articles we saw at the French Exhibition of 1849, and of which the ill-advised producers refused to send the like to London. In speaking thus of equality, I do not mean to affirm that the productions of the principal nations are identical, on the contrary, they are diverse; they have, however, a particular impression. They reveal special shades in the industrial genius, a distinct originality, but they evidence nearly an equal degree of advancement. If one excel in one kind of article, in another kind quite as difficult it is excelled by his neighbour; and it is not doubtful that the nation excelled has only need to be stimulated, to produce a work equal to that of the people excelling it. Supposing that the raw material were everywhere at equally low prices (and this would be the case very nearly if the

legislature would suppress, in certain countries, the artificial causes which induce high prices), the cost of production of the manufactured articles would be nearly equal. This is a conclusion that follows, I hope, from the premises. I propose, however, to go into this, for the purpose of establishing it, more in detail.

LETTER V.

IRON.

Iron, M. Thenard tells us, in his Lectures on Chemistry at the École Polytechnique, and he has repeated it in his published Treatise, is a metal so useful to man, that the civilisation of a nation may, to a certain extent, be judged of by the quantity of iron it consumes. Iron was extremely rare in ancient civilisation. It is well known that for a very long time arms were made not of iron, but of bronze. This is evidenced clearly by the writings of Homer. In these remote ages iron was esteemed a precious substance. When Achilles celebrated the games for the funeral of Patroclus, one of the prizes he bestowed was a piece of iron.

Times have materially changed; modern civilisation consumes an enormous quantity of iron, beyond all proportion with that which was produced, not only in primitive Greece, but even under the Roman empire. Since that period the process of its manufacture has been completely changed, having become more complicated since iron is no longer fabricated by the first casting. Much advantage has arisen from the discovery of processes by which the metal is more completely extracted from the ore, and by which less rich ores are rendered profitable. By the ancient method, that

of direct extraction, not more than 33 or perhaps 25 per cent of the metal was extracted from the poorer ores, such, for example, as contained only 30 per cent of metal. A still greater advantage of the modern method is, that it is conducted on a much larger scale, by which the cost of production is singularly diminished. The new process, which dates from six or seven centuries, consists in melting the ore in large tower-shaped structures called "blast-furnaces." An intermediate product is thus obtained, cast-iron, which is not malleable, and has not, like wrought-iron, the useful quality of being capable of being welded, but which is adapted to a thousand various purposes, to which malleable iron is not applicable. This cast-iron, on being submitted to a second operation, is changed into malleable iron, and this last is converted into steel.*

Since pit-coal has been applied to the treatment of iron ore in the blast-furnaces, the manufacture has acquired colossal proportions. This may be judged of by the inspection of the establishments in England, but more especially in Scotland. A Scotch furnace produces weekly 200 tons of pig iron, from which is obtained 140 tons of bar iron. About twenty men, divided into two gangs, are sufficient for all the work of the furnace. By the ancient method a small furnace was employed, producing at each operation, which lasted at least four or five hours, a small mass of iron of from twenty-five to thirty pounds, or at most forty, and the labour of four or five persons at least was requisite, the blower being worked by hand. When, as in Scotland and Wales,

* Steel may, however, be obtained directly from cast-iron; this is the case, for example, with the natural steel of Germany. Moreover, in the Pyrenees, where the ancient method is still continued, from the ore being of exceptional purity, steel is made in the first instance. A part of the block obtained at each operation is steel.

and in other places (less rare in France than may be supposed), iron and coal are fortunately found together, the manufacture may be enormous in quantity and the price very low. Human industry has then a powerful arm, which it uses advantageously to accelerate and perfect the production of wealth. I say an arm, I should have said an arsenal; for iron serves in industry a thousand uses, thousands of apparatus are made of it for multiplying and simplifying a thousand kinds of services which men in society receive and render, and which are as much entitled to the name of wealth as gold and silver.

Such effects are nowhere so conspicuous as in England, because it is the country in which the most iron is made, made the most easily, where it is cheapest, and consequently where there is the greatest inducement to use it. Cast-iron, malleable iron, and steel, are there seen everywhere; it is for agriculture as for manufactures, for domestic use as for factories, on land and on sea, an infinite and never-failing resource. Look at the tools here, from the lever to the plane, from the spade to the file, — cast a glance at all the domestic utensils,— take to pieces a machine, and examine one by one its various parts, — how strong and solid! How effective they must be in the hands of a good workman! Here there is no sparing of the material; it is not, as in the tools of India or China, or those of the Mussulman, where iron has been stinted because it is too expensive, where an inefficient form is given them because a superior form would require more metal, and because to enable them to manufacture the iron well, much iron, very much iron, iron of good quality under a variety of forms — cast-iron, malleable iron, and especially steel — would have been necessary. A difference of the same kind, but much less obvious, may be observed in certain tools and utensils of the continental countries,

because, on the Continent, iron has been hitherto much dearer than in England. We cannot but be struck, in examining the agricultural implements at the Exhibition, with the superiority many of them possess over ours from this cause.

A multitude of articles which everywhere else are of wood or stone, the former perishable, in both of an inconvenient volume and weight, are here made of iron. In the construction of houses and shops more and more iron is employed, to the great benefit of the public, who find in it, besides other advantages, that of economy. This economy is to be ascribed to the regular and permanent lowness of price, which results from keeping down the cost of production, and not of that which is accidental, and results from a political or commercial crisis; this is not lowness of price, it is a price below the value.

In England, a great number of fences are of wrought or cast iron. The small drains that, in our roads, are constructed in masonry for underground drainage at the intersection of roads, are almost always replaced by cast-iron tubes. Pillars of cast-iron are to be seen wherever you turn your eyes. In the docks, at Liverpool and at London, they are about three feet in diameter at the base, and no common weight would be sufficient to break them. Carpentry work, made of cast and wrought iron, is very common. Sometimes you find small erections in sheet iron, for instance, the station houses of the South-Eastern Railway all along the line; and where fire-proof buildings are required, the flooring and doors are made of iron. Many ships destined to long voyages, are built of iron (Mr. Porter estimates their number at 200 since 1830), and still more frequently the canal boats. What masses of iron are found on the roads which take their name in our language from that metal. Rails in iron, engines in iron, tenders in iron, fences in iron, machines of

all kinds in iron! An imitation of the American practice had caused the substitution in Europe, in the construction of railways, of sleepers in wood to blocks of stone, on which rested the rails. This was, at that time, an improvement. These sleepers now give way to plates of cast-iron. This idea was put in practice for the first time with us, on the Versailles Railway (rive gauche), by the influence of M. Henry, who conceived it. It is now gaining ground, and the recent experiments of Professor Barlow have proved that the motion of the trains on it is much more smooth.

The bridges and viaducts, so numerous on the railways, where it is essential to preserve the level as nearly as possible, were formerly of stone; but masonry is expensive, and stone is not fit for very large spans. On the French railways, for instance, from a prudence that I imagine is groundless, there is an objection to giving to stone arches more than 52 feet span. In certain countries, therefore, as, for example, the United States and France, wood has been had recourse to. The viaducts in France and America are very often of wood on stone pillars. The English, after some wavering, have decided on iron bridges, and now no others are constructed. It is thus that in endeavouring to ascertain the best means for employing this solid material to support railways, as it were in the air, they have attained an invention which will immortalise the name of Robert Stephenson, a son worthy his sire, George Stephenson, the inventor of the locomotive. I mean the tubular iron bridge, a magnificent specimen of which is erected at a hundred feet in height over the Menai Strait, in continuation of the Chester and Holyhead Railway. With this system of bridge the width of the span will create no difficulty; to cross the widest road without narrowing it by piers, without encroaching on it by pillars, is but a trifle. The two grand

spans of the Menai Bridge have an opening of about 400 ft. With this system, a bridge might be thrown over the Seine, at Paris, from one bank to the other, without piers or chains to support it. The tube measures, from end to end, 1509 feet, and it weighs 10,600 tons. A very pretty model of it was exhibited in the Crystal Palace. There was also to be seen by the curious, the hydraulic press which was used to elevate the tube to the height at which it is suspended. It is an enormous machine, and appears to be made for the Titans.

In England, iron being so cheap, they are not satisfied with employing it in all kinds of apparatus, but considerable constructions are made with it. It is long since bridges were erected of cast-iron. When, at the end of the last century, an American invented suspension chain bridges (the bridge at the little falls of the Potomac, near Washington, which was the first ever erected in either hemisphere, is still to be seen), the English adopted the invention with ardour. They have used it extensively. Of all their suspension bridges, that constructed by Telford over the Menai Strait is the most renowned; it is now, however, eclipsed by the work of Stephenson — "Sic transit gloria mundi!" It is from the English we have derived this invention. We have largely used it; and of all the suspension bridges which exist, the boldest is the bridge of Cubzac, where may be seen, under another aspect, the advantage of iron in construction. The pillars which support the bridge of Cubzac are in cast-iron. In masonry, they must have been twenty times more cumbrous, and would have sunk in the muddy bed of the river, carrying the bridge with them. The English engineers have considerably extended the use of suspension bridges. The Exhibition contains a very accurate model of a suspension bridge of unusual dimensions, which is now in course of

erection by an English engineer, Mr. Vignolles, at Kieff, on the Dnieper. It must be nearly 2600 feet long in the roadway, and will have four spans of 440 feet, and some smaller ones.

But suspension bridges have become already matter of history; the most recent novelty is the iron lighthouse. I know two examples. I do not know that they are the only instances. One is in Ireland, at Fastnett, being 80 feet high from the base to the gallery, and having the base formed of a tower of 25 feet in diameter. The crowns in cast-iron, of which the tower is composed, are only an inch and three quarters thick. Another, more elevated still, is erected at the Bermudas, on the height called Gibbs's Hill. The total elevation of the lighthouse is 110 feet. The cast-iron in it, however, is thinner than in the preceding. Before the Californian emigration, the English already constructed houses in iron. One has been sent to Port Natal, in Africa, of 78 feet in front,—this is the width of a fine hotel at Paris,—and 60 feet in depth.

The facility of employing cast or wrought iron has introduced into every-day life in England new usages, productive of neatness, comfort, and economy. Cast-iron pipes being at a low price, have been an inducement to multiply the conduits for water and gas. The distribution of water is very well understood in England. Water is thus distributed, even among secondary towns, from sources placed above the level of the highest houses, and therefore capable of being supplied in every room. The gas companies think nothing of the extent of their pipes. Some of them extend their supplies over a radius of from four to seven miles. The Vauxhall Company, for example, commands a radius of the latter magnitude. Thus the consumption is augmented, and the price reduced. At this moment, in London, in the

populous quarters, such as the City, the price of gas is 4*s.* per 1000 cubic feet; in other quarters it amounts to 5*s.* At Paris it is about 12*s.* 6*d.* As in England much pains is taken in purifying the gas, private persons employ it more extensively every day for their houses, and they begin to use it for cooking, an application of it which is attended with increased convenience, neatness, and economy.

I have already noticed how useful to agriculture is the low price of iron. I could mention various other uses to which the English agriculturist applies it. I lately visited one of the best-managed farms in Shropshire, and remarked there a sort of apparatus composed of cast-iron pipes, which, by means of a suction and forcing pump, was used to carry the liquid manure from the reservoir containing it to a distance of some five or six hundred yards. The portable steam-engine, which is now to be regarded as adapted to agriculture, and of which several specimens are shown in the Exhibition, arises from the desire of the English to utilise iron for all their utensils and apparatus, on account of its low price. An engine, mounted on a solid carriage, and of three or four horse power, will cost from 80*l.* to 200*l.*

The exhibition of the malleable irons, cast-irons, and steels of England, as well raw as manufactured, was splendid. It was extremely vast and varied. It indicates gigantic means of production, and attests an enormous consumption. It comprises every condition of the metal, from the rough ore to the most massive round or square bars; from the circular saw of the largest diameter, to the hardest, and finest, and most accurate file. We see there plates of sheet iron of gigantic dimensions, others extremely thin; iron wire so fine as to be invisible, and every imaginable article of hardware and cutlery. The files particularly attract the attention of connoisseurs. The steel, which, by the way, is made from

Swedish iron, is one of the triumphs of English industry; it is produced abundantly, of the best quality, and sold throughout the entire globe. Much more of it would be sold, if, by an inconceivable aberration of mind, several of the continental governments, in the view of protecting their national industry, had not imposed exorbitant duties on the cast steel of England. In France these duties are the most onerous. Singular mode truly of protecting industry, by preventing it from obtaining good steel, a material indispensable to good tools! But it is an example with how little wisdom, as a celebrated writer said, the world may be governed. In the division in which the products of Sheffield and Birmingham are exhibited, the English exhibition is resplendent. The English mould and model steel with remarkable skill, and give it, moreover, the finest polish. Their polished steel grates, set in black marble or blackened cast-iron, excite the admiration of foreigners in the Crystal Palace. Their cutlery and hardware enjoy a reputation which is increased by the attraction of being forbidden fruit, since the greater part of these articles are prohibited abroad.

There is one punishment I would inflict on our prohibitionists, and which would be fair retaliation,—it would be to interdict them the use of English razors. It would be bringing some of the consequences of prohibition home to themselves, if, on their return from England, they were forced to make presents to their wives and daughters, not of English needles or scissors, but needles and scissors of French fabrication. If they object that this is tyranny, we reply, it is of their own invention; and we will read them some of the bombastic tirades they have taught us by continual repetition, on the necessity of using exclusively French products, and excluding those of " perfide Albion."

And the very building of the Exhibition, what an example of the part played by iron in England!

But what is the extent of the production of iron in England? Mr. Porter, in his excellent treatise, entitled "The Progress of the Nation," has collected the existing information on this production at various periods. In 1740, it was 17,390 tons of raw iron. This small quantity enables us to judge what was the extent of the industry in iron in the ancient countries, and what it might have been in ancient times, when the process of fabrication was so imperfect. It appears, however, that before 1740 it had been a little less. In 1750, it was 22,000 tons; in 1788, 68,000 tons, at which time the fabrication of iron by coal was known, and had come into general use. In 1806, it was 250,000 tons; in 1820, 400,000 tons; in 1840, 1,400,000 tons; in 1849, 2,200,000 tons. We still speak of cast-iron. Scotland is distinguished from the other parts of the United Kingdom, by the especial rapidity of the progress of this manufacture. In 1827, it produced 37,000 tons of cast-iron; it has now reached 700,000 tons. According to a statement published by M. Heron de Villefosse, in the "Richesse Minerale," about 1806 or 1807, the production of all Europe, comprising England, in forged or moulded iron, did not exceed 772,000 tons, which might represent, at most, 1,100,000 tons of raw iron. We may notice here, in passing, that this is an indication that progress in the production of everything is one of the consequences of peace; and another, the supplying the wants of man, or, in other words, increasing his wealth. I say everything, for in certain articles,—the tissues of wool and cotton, for instance,—the ascensional movement has been more rapid at least in England. It is thus that England, which, about 1814, consumed less than 55,000,000 pounds of raw cotton, con-

sumed, in 1849, 775,000,000 pounds. In 1806, forged iron cost about 16*l.* sterling to make a ton; the expense now is about 5*l.*, or 5*l.* 10*s.* The raw cast-iron in pigs has had a more considerable reduction. No longer back than in 1835 it was worth, at Glasgow, about 4*l.* 2*s.*; now it is to be bought at 2*l.* or 2*l.* 8*s.* the ton.

In other countries the production of iron has not increased near so much. In France, from 1806 to 1847, it has quadrupled.

The produce in France in 1847 was 520,000 tons of cast-iron, but we imported besides near 100,000 tons, whilst the English exported it; and our production in iron would have been still more considerable, and the diminution in price would have been more decided, if this article had been subject to foreign competition. The fabrication thus has been continued by the old defective methods. When new establishments have been formed, the best localities have not always been chosen; there was protection, and under the shade of the customs' tariff, it was believed a market would always be found; and much iron is still made with charcoal, which augments the cost of production.

There are localities in France where the manufacture of iron might develop itself as in Scotland, if the stimulus of foreign commerce had obliged the producers to adopt with care the points most favoured by nature as respects coal and ore. I would mention, amongst others, Aveyron, the resources of which in ore and coal are prodigious. Our customs' duties are 150 per cent on forged-iron, in heavy bars (about 8*l.* 5*s.* on an article worth about 5*l.* 10*s.*), more than 200 per cent on sheet-iron (nearly 18*l.* on about 8*l.*), and 250 per cent on iron wire. All these duties are equivalent to prohibition. Except a small quantity of Swedish iron, which we convert into steel, we import no foreign iron.

On raw cast-iron the duty is 125 per cent (about *3l.* 1*s.* on *2l.* or *2l.* 8*s.*), and France is so ill-supplied, that our founders send to Scotland for a large quantity of castings, notwithstanding the immense duties. All this, be it observed, takes place under the authority of a constitution which expressly guarantees to all French citizens the liberty of industry, which in our days means nothing, if it do not mean the faculty of providing the means necessary to industry where they are to be procured the best and cheapest, without having to pay for protecting the interests of a class. But these abuses are about to vanish; the real principles of liberty and justice will by degrees make their way. The error that has so long continued the prohibitory system in Europe, the privileges which were protected by the tariff without the serious concurrence of the legislature, are being detected. Free trade, one of the principal features of civil liberty, is triumphant on the northern shore of the Channel, and it will not be long ere it will be so amongst us. We are not living in times when it can be said, "Truth on this, and error on the other side of the strait." Truth, like liberty and justice, is henceforward common for all Europe.

LETTER VI.

FRANCE AND ENGLAND.

Let us now compare France with the other Western nations who have sent their products to the Exhibition, but particularly with England.

Let us take the tissues, and first those of silk. This glass case, which Lyons has been so late in sending, is the admiration of every one. Crowds press to catch a sight of these wonderful productions, which are incontestably all that is most finished, most ravishing, most perfect in the art of silk manufacture. The selection of this assortment of articles has been made, it must be admitted, with especial care by the Chamber of Commerce of Lyons. Nothing is wanting, from plush to the finest velvet, from the most simple plain to the most varied figured silks. And what can be more beautiful than the ribbons of St. Etienne, set out near to these? Let us pass to the woollen stuffs. We must ask the tailors of London what they think of the fine qualities of cloths sent from Sedan, represented in the Exhibition by the products of Messrs. Bacot, and Messrs. Bertèche and Chesnou, and what they think of the "nouveautés" of the same town. They send for them, because nothing is more agreeable to their superior customers. We will now go to the merinos. They are an article much in demand. The tradesman will tell you, not only in England, but in any part of the globe, that every lady who wishes to have a handsome dress of this kind, asks for French merinos of the manufactory of Cateau, conducted by one of the most eminent men of the French industry of merinos — Paturle, in a word, for it is under this

name that the merinos of Cateau are known in the two hemispheres. Of these the exportation is very considerable. Thus, in woollen goods, we have the precedence in fine cloths, and bear the palm in merinos; we are the first in mousselines-de-laine, also an article in great demand, of which may be seen charming samples from Mulhouse in the Exhibition. Of these two we export considerable quantities. We are first in common and printed shawls, of which the French division contains some beautiful specimens; these we export considerably, and for the superfine shawls we fear no competitor. Also for the barèges, a very charming article, in which silk is mixed with wool, the warp being of silk, and the woof of wool. It cannot be said of these goods, that it is the beauty of the design which alone gives us superiority, although it does not derogate from it. Even in the spinning of wool, a mere mechanical operation, we are equal to the English, who are such great mechanicians. To prove this, I will do what I might have done already for the cloths, the merinos, the mousselines-de-laine, the shawls. I will not content myself with taking you alternately to the English and French divisions, and saying to you compare and judge! I will refer you to the commercial returns published by the Government. It is so true that we spin the wool as well as the English, that they require us to be their spinners. Rheims and other places furnish them a great quantity of spun wool, of the kind known as carded, which is principally sent to Glasgow, where it is used to make the common shawls called tartan. For some time another and more curious phenomenon has presented itself. We buy in the London Docks,—you will observe in the London,—raw wool, wool carded, or rather to be carded. We prepare it, we spin it, and we return it all ready for weaving to the English, who find it more advantageous to buy of us, notwithstanding

the cost of transport to and fro, than to spin it themselves. In fine, to crown our superiority in the spinning of carded wool, our factories use a carding machine, made by the house of Schlumberger of Guebwiller, which gives unhoped-for results. It is this apparatus that enables the factory of Cateau to make the superior merinos it exhibits.

Cotton — it is the triumph of the English. The quantity of raw cotton they consume for their spinning, their weaving mills, and printing, is surprising, is fabulous, — 325,000 tons. They sell such enormous quantities over and above what they consume, that to express by a simple number the magnitude of their exportation, a unit must be sought, not in anything familiar to us, and instead of the yard or the league, that of the circumference of the earth must be adopted.

The exportation of the English in calico and printed cloth, amounted, in 1849, to more than thirty times the circumference of the earth; and if to this be added what the thread exported would make, if converted into calicos or cotton goods, a total would result of fifty times this gigantic unit. I know one manufacturer of printed cottons at Manchester, Mr. Schwabe, whose annual production is 700,000 pieces of rather more than 27 yards each. This is 20,000,000 yards, and the circumference of the earth is not more than 44,000,000 yards. For cotton, however, I have asked persons beyond suspicion, manufacturers of Manchester, cotton printers, with whom I have walked through the Exhibition, if they expected to obtain the first prizes. "Here are our masters," they have replied, pointing out to me the products of Mulhouse; and, in truth, nothing can be more beautiful in printed cottons than this collection of articles. It is a wonderful assortment of colours, an admirable collection of designs; there was one piece in particular, representing bouquets of tulips, before which the amateurs stopped as be-

fore a *chef-d'œuvre.* Two or three other groups of flowers were also well worthy attention, especially one in three shades of red. The application of the beautiful red, called Turkish red, on cotton, is, as is well known, due to one of the Kæchlins of Mulhouse. No person in the world equals for printed cottons the Dolfus-Miegs, the Hartmans, the Odiers Gros, Roman & Co., and their worthy "confrères" of Alsace, unless it be M. Japuis of Claye (Oise), who exhibits the most surprising articles. The factory of M. Japuis has this peculiarity, that all the work is done by women. These magnificent prints are not of exorbitant price, selling at from 7*d.* to 2*s.* 3*d.* the yard. We export of these a considerable quantity. The English sell in foreign markets the most common prints at lower prices than we, but the truth is, they give the consumer merely the value of his money; they are of a very indifferent quality. They have also an enormous trade in cotton thread. This is one of their excellencies and means of wealth. I find, in the excellent "History of the Cotton Manufacture," by Mr. Baines, that the Indians, by the incomparable dexterity of their fingers, have succeeded in spinning the No. 200., and that in some few cases they succeeded in making as fine as No. 250. It is with these numbers the muslins are fabricated. The English latterly have spun to Nos. 500., 600., and 1400.; and a specimen may be seen at the Exhibition, of the house of Bazley of Manchester, of the No. 2070.* I speak now of the English numbers; according to French measure, they would be about one fifth less. These high numbers are instances of skill without precedent hitherto. Almost all the consumption is below No. 200. As to the threads the most in demand,

* This is of such fineness, that at least 2,000,000 yards, that is, about four times the distance from Paris to Marseilles, are necessary to make about a pound weight.

our present inferiority is very inconsiderable, if even our best spinners have, in comparison with the English, any inferiority whatever. One of our manufacturers of the highest consideration, who is at the same time a spinner, weaver, and printer, M. Jean Dolfus, has incontestably shown that, in Alsace, such of our spinners as use water power, are quite in a condition to compete with the English spinner, because they produce at the same price. As to those whose motive power is more costly, if regard be had to the difference of the workmanship, their cost prices are not higher than those of Manchester. In any case, no one can deny, that if we allowed free importation to the raw calicos or spun cottons of England, we could sell at lower prices the prints made from such importations. But we take care not to derive this advantage. When the printers of Rouen or Mulhouse demanded permission to import the English calicos on condition of re-exportation, the reply they received was, that they were the enemies of national industry.

I could prolong this review of tissues, and I should, from incontrovertible evidence, arrive at the same conclusion. I much doubt if there be any important class of tissues, in which, taken altogether, and especially for the better qualities, we have not arrived at equality with the English, however skilful they be; and the number of articles of general demand in which we surpass them, is almost as great as that of the articles in which they excel us. For the cotton tissues independently of the prints, for the embroidered articles, for instance, we are superior to them; for the linen cloths, and particularly for the damasks, we need not fear either England or Saxony. We are, in fine, in all respects, a great manufacturing power.

But let us examine the English in their forte. I have already spoken of the cotton spinning. Let us advert to the

machines. The English construct these very well, and have sold, and are selling, them to the whole world. In these, however, we have ceased to be their inferiors. The classical machine is the steam-engine. If, by an inconceivable oversight, we had not neglected to send to London some of the latest models from Paris, Rouen, the North, or Alsace, we should have astonished the English themselves. Our steam-engines have arrived at the greatest simplicity of construction; they work as well as the English engines, do not go out of repair more, and consume less fuel. We apply better than they, in a more intelligent manner, the expansive principle. As to marine engines, of which a superior specimen is exhibited by Mr. Maudslay of 700 horse power, and by several very remarkable apparatus of Mr. Penn, the English have had so much experience that they have succeeded perfectly. Since the enterprise of the transatlantic steam-ships, humiliating for the Government that took charge of it, and disastrous for the Treasury, we have built very few marine engines; but we manufacture admirably the engines destined to river navigation, as an instance of which we need only refer to the Rhone. With the tools and workmen that we have, we could very well execute engines for long voyages, if our constructors had a certain number to make, that is, if the Government ordered them to be made, instead of making them themselves. As to marine engines, we cannot but remark, that the English have thought fit to borrow from us the oscillating engines, which have been brought into notice in France by the house of Cavé, at Paris.

On this head, I cannot forbear to express my great astonishment that our Government, who have established a large factory for engine-building at Indret, who have erected similar factories in all the maritime arsenals, have not thought fit to send to the Exhibition one of our marine engines after

this model. When we engage in industry, we ought to submit to its conditions. We may be a Government, but we are not exonerated from the obligation of exhibitors at such an Exhibition. When we decline to compete, we give the public reason to think that we are fearful of the result of comparison. If I had the honour of being a member of the National Assembly, the absence of the products of our marine administration at the Palace of Crystal, would be in itself enough to cause me to vote the shutting up our establishment of Indret. The national manufactures of Sèvres, of the Gobelins, and Beauvais, were exhibited because they are superior productions. The visitors of the Exhibition of London draw the conclusion that if the Indret does not exhibit, it is that the Indret engines are inferior.

Even as regards the locomotive, the French constructors are equal to the English. We have here only one specimen; it is an engine of Cail of Paris, intended, if I remember accurately, for the Lyons railway. Experience, whose judgments are without appeal, has decided that our principal establishments construct these apparatus as well as the most eminent English makers. The prevailing model at present, both with us and in England, is that of Mr. Crampton, which unites great power with great solidity. The Northern Railway are about to have engines of this system, which will draw 500 tons weight.

As to the steam-engine, I will notice here an honour that we share with others, but of which the greater part belongs to us. The steam-engine was called, in the first instance, a "fire-engine," because its distinctive property is the use of fire to develop the elastic vapour that the engine transmits to a rotary axis, and which from thence is conveyed to any desired machinery. For a long time it has been a question, if some other elastic force could not be more advantageously

employed than steam, that is, one that would produce a greater useful effect with the same quantity of fire, or, to speak more technically, with the same cost of fuel. The power of air, heated to a very high temperature, has been proposed. Some time since, experiments have been made with ether, which, as is well known, vaporises with great facility. It is particularly in France that these experiments have been made. There may be seen in operation, for the last four years, in the glass-works which are situated at the gates of Lyons, in the Faubourg of the Guillotiere, a fire-machine in which ether is substituted for water. It is of 25 horse power. It is certain that it is of very easy operation, that it gets out of order less than a steam-engine, and requires less repair. The same ether serves indefinitely, except an insignificant loss of about a quart in twenty-four hours. As in this establishment ether is heated by steam which would otherwise be lost, which escapes from a high-pressure steam-engine, the 25 horse power is a clear gain. The inventor of this remarkable engine is M. Dutremblay. The inventive faculty is now turned towards another liquid, a well-known rival of ether, for a use eminently humane, chloroform. Some beautiful experiments have been made on the vapour of chloroform by an inventor, M. Lafond, who, succeeding M. Dutremblay, has improved on the invention of the latter. At this moment, a fire-machine of this new kind, of 120 horse power, is in course of construction at the cost of the State, in the navy yard of L'Orient, under the superintendence of a committee, presided over by one of our most distinguished engineers, M. Reech, director of the school of maritime engineering. We will not attempt to predict what may be the result of these attempts, experience will give its dictum in a few months; but I felt bound to

mention them here. They supply a curious proof of the initiative, full of boldness and energy, that France has taken in the useful arts.

As to the machines destined to the fabrication of tissues, and especially to the spinning of cotton, flax, and wool, we export them, which is the best proof of the skill we have acquired. Alsace and Paris, the André Kæchlins, the Schlumbergers, the Decosters, and others, will not give way to any competition for good workmanship. It is well known that we now furnish looms, in great quantity, to Switzerland and the south of Europe, and even to Germany, notwithstanding English.

There are many other machines for which we have reputation, the superiority of which is well known. I have already mentioned the machine for making endless paper, but I would now direct attention to the hydraulic machines. For more than half a century, since Watt produced his beautiful improvement of the steam-engine, before which, for forty years, the art of the engineer stood still, as before a work which compelled undivided attention, the English employed, with a predilection almost exclusive, that machine. It is on that account, probably, that amongst our neighbours on the other side of the Channel, the machines driven by the motive power of water did not receive the improvements introduced in them with us. We improved the hydraulic wheels; we invented the "turbine," a powerful apparatus, now much simplified, which will perpetuate the name of our distinguished engineers, such as M. Burdin, and of our skilful constructors, such as M. Fourneyron and others. A French "turbine" was seen, of the system of M. Fontaine, at the Exhibition. The public, which everywhere is ignorant, passes on without casting a glance at it; and, on the contrary, presses in crowds before an hydraulic machine of

English invention, working by centrifugal force, which raises and throws out a sheet of water, on the merits of which, at present, I ask to be allowed to remain in philosophic doubt.

But let us not wander from the "forte" of the English. There was in their Exhibition another category of articles which justly engaged attention; these are the instruments and utensils in iron of every kind, malleable iron, steel, and even cast-iron. They manipulate, with extraordinary skill, these stubborn substances, and make of them what they will. Iron, under all its forms and in all its states, plays so considerable a part in England,—it is so powerful an auxiliary of industry in general,—that I could not dispense with consecrating an especial article to it. It is the legitimate pride of the English to excel in working that metal in all its varieties. Here are specimens of all kinds; cast-iron pipes, in which a boy of ten years old could stand upright, and of which 4500 have been cast at Glasgow; gigantic sheets of iron, rails of an unheard-of length; and then grates, some all in steel surrounded with marble, others half cast-iron, half steel, which are very beautiful. In the hands of the English, steel receives a splendid polish. This same steel is the material of thousands of tools. The English cutlery enjoys great reputation, so do their straight and circular saws, their files, particularly those of large size, which are unparalleled. They have a large body of workmen who excel in all these manufactures. Without contesting the skill of the English, I will here venture to affirm that, in the most difficult works of cutlery, the *élite* — a few of the very *élite* it is true — of our manufacturers succeed as well and even better than they. Everything succeeds with those who will take the trouble. It is notorious, in Europe,

that the surgical instruments of M. Charriere, instead of being inferior to those of the English makers, have, on the contrary, some superiority. M. Charriere is vehemently suspected of using the cast-steel of Sheffield; but he is not to blame for that. He takes his raw material where he is sure of finding it good. He is entitled to do so; it is, indeed, his duty to his customers. If any one be to blame in this, it is the legislature, which obstinately prevents, by a monstrous duty, the excellent foreign steels from entering France, whence so much advantage would be derived to the alimentation of national labour, and in the fabrication of articles that we should afterwards export with profit. There was likewise here a large locomotive boiler of French fabrication (of the house of Cail), which attested to what point we have attained in the working of iron.

A machine, imposing by its dimensions, was to be seen in the English Exhibition. It is the hydraulic press used in the construction of the famous tubular bridge in wrought iron I have already mentioned, which Stephenson, the engineer, has recently thrown across the Menai Strait, to carry the railway which conveys the Irish mail to Holyhead, the western point of the Isle of Anglesey. This press excites attention because it is colossal; but it derives almost all the interest that attaches to it from the bridge itself. It is, in fact, a veritable progress in the art of construction on a large scale, its dimensions being prodigious. It consists, as I have told you, of a tube made of iron plates riveted together, which rests on three pillars, so arranged that the two central arches have the frightful span of about 500 feet. A model of this bridge was shown in the central gallery of the Exhibition, which also gave the details of the process for raising the tube to the elevation at which it is suspended. I cannot, however, abstain from remarking, that the cast-

iron bridge now in course of construction over the Rhone at Beaucaire, and which has arches of about 200 feet span, may well be considered as parallel with the magnificent work of Mr. Robert Stephenson. The arches there are formed of blocks of iron, like arch stones, supported by one another in the same manner as are built arches in stone. The bridge of Beaucaire proves that we are perfect masters of works of that class in cast-iron. It has a solidity equal to any test, and a span wide enough for all purposes. The parts of the bridge of Beaucaire are cast and prepared at Fourchambault, in the workshops of M. Emile Martin, on the plans of M. Paulin Talabot.

Even hardware, with respect to which we have the reputation of being behindhand, we execute well. Inspect the articles exhibited by the *élite* of our manufacturers, such as MM. Japy, Goldenberg, Coulaux ; they are certainly entitled to commendation, they are well made. Many of these would be exported, but for the cost of the raw material, that is, iron, cast-iron, and steel, which are only at this exceptional price with us in virtue of a customs' law.

Iron, cast-iron, and steel, are not the only metals that we know how to work well. With zinc we make all kinds of remarkable articles. The mines of the Vielle Montagne deliver to us their products, that we manufacture very skilfully. The uses in the arts to which this metal has been applied, are very multiplied. We have even succeeded in casting works of art of very large dimensions. One of the largest pieces of the Exhibition, was the statue in zinc of the Queen of England on her throne. In fine, we work copper with real superiority. The construction of large copper boilers in France is more extensive than in any part of the world. The house of Cail has long been known in the two hemispheres for its great apparatus for boiling and

refining sugar. The name of this house has frequently recurred in my letters with eulogy. This is, first, because it constructs many things very well; and secondly, because, among our great constructors, M. Cail is almost the only one who has sent to the Exhibition many articles. He deserves to be commended for having thus heartily supported French industry, and caused it to appear in all its "éclat." I ought also to notice the articles exhibited by a house devoted to the manufacture of boilers, that of Givet (Ardennes), who has sent to London, besides other articles, two brass boilers of the most finished workmanship.

France seems ignorant of her productive powers, of the manufacturing genius which distinguishes her. She has before her the finest industrial career, provided she does not herself fetter it, provided she consent to do away with the artificial difficulties which limit the full expansion of her children. France has nothing to fear in industry, if it be not her own prejudices, her ignorance of her own wants, her condescension for men who foster in her the superannuated notions of false patriotism. This will be more completely established, when I shall have finished the summary review of the principal branches of production.

LETTER VII.

INDUSTRIAL RIVALRY OF FRANCE AND ENGLAND.

In the preceding letter, I commenced a parallel between French industry and that of the great nation which, confident in itself, has given hospitality in the Crystal Palace to the productions of the world. I have shown that, although

inferior in certain points, we have acquired an advantage in others. Between the two rivals the distance is never great, unless it be in articles in which taste has a great share, for then our superiority is almost always striking. I say *almost* always, for to this rule I shall have to note some exceptions. I must add that, in pointing out the parity of industrial distinction between the two countries, I have in view, in the first place, the good workmanship of the productions. As to cheapness, it must be agreed that, on several points, we labour under a disadvantage which is sometimes enormous: but this dearness of French manufactures is very often factitious; it is, in fact, more frequently to be attributed to artificial causes, over which the legislator may, when so disposed, exercise a sudden and decisive action, for it is he who has raised them and who maintains them, out of respect for a theory, the fallacy of which has been clearly demonstrated. It is the tariff which sometimes materially increases the price of the raw material, particularly iron and steel, to the great detriment of national industry, and creates, in some cases, real monopolies, fatal to the progress of the arts, and incompatible with the liberal tendencies of modern civilisation. The great amount of English capital, from whence results the extent of operations, is nevertheless, also, in certain circumstances, a cause of the cheapness of English productions, for a diminution in the general expenses is caused by it. If a pattern for printed goods only serves a French manufacturer for the fabrication of two hundred pieces, whilst the English manufacturer obtains from it eight hundred or a thousand, it is proportionally a larger sum which the former pays to the designer and the engraver, and for the purchase of the copper for printing cylinders.

Let us continue this comparative examination for the principal branches of manufacturing industry; it will be the

means of controlling and of confirming the conclusion which I have just stated.

One of the most useful branches of industry, one of those with which neither the poor nor the rich can dispense, is that of earthenware. From porcelain to delft and to the most common stoneware — from the finest earthenware to the common pitchers covered with a greenish yellow glaze obtained with potter's clay — there are a prodigious variety of utensils which men have constantly under their hands, with which they furnish or ornament their tables, their mantel-pieces, and their dwellings. On this point, the palm incontestably belongs to the national manufactory of Sèvres, not only for the beauty and elegance of form, the merit of the painting, and the ornamentation, but also for the whiteness and solidity of the paste, and the hardness of the glaze. No establishment in the world equals that of Sèvres, and its productions excited general admiration at the Crystal Palace. For some years past, Sèvres, which had before enjoyed a high place in the esteem of connoisseurs, has made extraordinary progress. The revolution of 1848 was a stimulus for Sèvres. It was necessary to justify, by fresh claims, the exceptional favour of being inscribed by the title of national manufactory on the budget, which was in deficit. It was necessary to attract customers by a production which should be of a moderate price without ceasing to be perfectly good, for Sèvres now sells its productions to whoever wishes to buy them. Sèvres is no longer devoted to the exclusive use of kings; it makes plates for all customers at 30*s*. a dozen. Hence arose a complex problem, admirably solved by the learned engineer who, before his death, was chosen by the venerable M. Brongniart as his heir, M. Ebelman, to whom chemical and mineralogical science is indebted for some valuable discoveries (it was he who found the means of fabricating rubies,

which neither chemist nor jeweller could distinguish from the natural stone). Supported by a committee of superintendence composed of men of much taste, the new director has carried Sèvres to a pitch of advancement, equally glorious for France and himself.

Sèvres now commonly makes articles as thin as paper, which leave the fine cups of China far in the rear. It is a manufacture which seems likely to be a source of profit for the establishment. A cup and saucer, superior to anything ever produced in China, is sold at 5*s.*, leaving a profit of 33 per cent.* It is by the process of casting, that is to say, by running the liquid paste into a mould, that these charming articles are manufactured. In China these cups are obtained by the ordinary process of hand moulding; thus in China it is still a costly article. The process of casting has this extraordinary quality, that it also supplies the means of forming articles of the largest dimensions, ornamented with the most delicate mouldings, including figures of the finest design. The Sèvres establishment has produced a baptismal font of this kind, in biscuit, measuring more than five feet in diameter. Sèvres also makes enamels with extraordinary success. M. Ebelman conceived the idea of substituting sheet iron for copper to receive the enamel, as the temperature which is necessary for the production of enamel copper is near its point of fusion. An enamelled plate of copper, therefore, when it exceeds a certain magnitude, becomes distorted in the fire. Iron resists this effect infinitely better, in consequence of its point of fusion being more elevated.

By this expedient, figures in enamel of a height exceeding forty inches have been produced.

* The price of a cup and saucer plain, without gilding, is only three shillings.

Sèvres is thus truly at the head of the art; it opens new paths to private industry, it furnishes it with new processes, it gives it models. This is what establishments supported by the State ought always to be, but what they rarely are. With our manufactory of the Gobelins, where an illustrious *savant*, M. Chevreul, has spread such light; with the Imperial Printing Office of Vienna, which possesses an unrivalled collection of characters, and which uses them in a superior manner; with our own National Printing Office, and a small number of other European institutions, Sèvres forms a group of very great interest. It is with regret that we cannot unite in it the Royal Porcelain Manufactory of Meissen, in Saxony. This establishment, formerly so renowned, is not progressing; it no longer renders any service to the art; it follows in the wake of others. Happily, Saxony does not require royal establishments to be one of the most honoured competitors in the career of the useful arts, as in sciences, letters, and the fine arts.

With regard to porcelain, the baking with coal is a progress henceforth acquired. After many fruitless attempts, success has been completely obtained. The merit of this belongs to M. Vital Roux, who, previous to 1848, had a manufactory at Noirlac (Cher); it is he who at present has the direction of the ovens at Sèvres. No other mode of baking is now pursued there. The saving is considerable: with wood, every baking at Sèvres cost 36*l.*; with coal it does not amount to 7*l.*, although that combustible is very dear. In general, in the process of baking, 35 cubic feet of wood is replaced by 5½ bushels of coal. In England and in Belgium, as well as at Sèvres, the use of pitcoal instead of wood is established. Wood is still used in Limousin, where the most considerable porcelain manufactories in Europe are to be found. Coal would there be

too expensive. Here there will probably be an example of the perturbations which attend the majority of improvements, because it appears that it comes within the designs of Providence, that the human race should purchase, by the sweat of the brow of some of its children, every benefit which it enjoys. It is very probable that the effect of this improvement will be to transport the porcelain manufacture from the valley of the Haute Vienne to that of the Cher. The porcelain paste prepared in Limousin, will go and seek the mineral fuel in the Berry.

For porcelain properly so called, hard porcelain, that is, white earthenware, having a semi-transparent paste, composed principally of kaolin, with a glaze of felspar, France has the advantage over England and over all Europe. The English, who have, nevertheless, very fine beds of clay in the county of Cornwall, use them but little. The porcelain manufactures of Limoges produce articles at a low price, and their cheap goods are not wanting in taste. The houses of Jouhanneaud, Vallin, and some others in that branch of industry, export large quantities into some countries where their production is not subject to an excessive duty. The United States at this moment receive large quantities of the porcelain of Limoges. But for fine earthenware, of which delft ware, formerly esteemed, is now the most humble specimen, England excels. She has productions the composition of which is very varied, I mean to say that she has pastes of different composition. With her this manufactory is nevertheless concentrated in a moderate number of gigantic establishments, almost all in Staffordshire, among which may be cited that of Etruria, the property of the Wedgwood family, those of Messrs. Minton, Adams, Ridgway, Meigh, &c. There exists, besides, another at Glasgow, one near Newcastle, and, in fine, one near Worcester.

Mr. Wedgwood perhaps follows too faithfully the traditions of his grandfather, a man of great skill, who much advanced the art, and whose name is known in the two hemispheres, for he spread in profusion, to the great satisfaction of all people, his productions, which were then unrivalled; with the exception, however, of France, where a law of war, which is still in vigour on this point, prevented them from entering even as samples. The same paste is now used at Etruria, and nearly in the same form as formerly. This paste is a mixture of plastic clay and felspar. The paste of Mr. Minton combines the kaolin, a superior raw material, with plastic clay. Its glaze, like that of the earthenware called tender porcelain, contains lead, not an atom of which is contained in true porcelain, but in which there is felspar. Mr. Minton also manufactures fancy articles with a paste which advantageously replaces our biscuit china. It has the slight yellow tinge of ivory, and has a soft appearance. These are the articles which are much admired at the present time under the name of Parian paste. It is pure felspar. He also makes tender porcelain, an article which has the advantage of lending itself to painting, but which has the inconvenience of being readily scratched. This kind of article, the manufacture of which has been long abandoned at Sèvres, is about to be resumed, to satisfy the wish of the public.

We nevertheless succeed very well in several articles of common use in fine earthenware, such as table services. Creil and Montereau turn out some very pretty ones in painted earthenware. With large articles they do not succeed so well. The superfine earthenware of Sarreguemines, where they produce articles like those of the Potteries, I mean to say composed of paste and glaze of the same kind, is not represented in the Exhibition — a circumstance to be

regretted, since the establishment produces articles of great beauty and large dimensions. Porphyry is there imitated so well as to deceive connoisseurs. In the national palaces, urns, which are thought to be of Swedish porphyry, are in earthenware, from the manufactory of Messrs. Uzschneider of Sarreguemines. But fine earthenware in general is dear in France; it is so, not on account of the difficulties attendant on its manufacture, but from the absence of competition. Sheltered by the absolute prohibition with which they are favoured by the customs' tariff, the manufacturers, reduced in number to two or three, sell their productions at their own price; and no one dares raise a rival manufacture, from a fear of being exposed to a struggle against opponents whose long accumulated profits would enable them to support, for a time, an enormous reduction in price.

In the very common earthenware, which is called stoneware, we have recently made great progress; we now make it better than any one. The invention of it is due to a skilful painter, M. Ziegler, who established a manufactory for it at Voisin Dieu. The stoneware is now made by us of very pleasing forms. It is only to be regretted that M. Ziegler should have applied his fine talent to an article so common, we may even say, so ungrateful. It is a mixture of sand and plastic clay.

Crown and flint glass constitute another branch of industry very useful to man, and extremely varied in its productions. It has received admirable improvements in modern times, even more so than earthenware; for, if the ancients had on their tables only plates and dishes badly glazed, or not glazed at all, they at least made for ornament vases of the greatest beauty, found in all collections of antiques. The glass of the ancients was, on the contrary, still in its infancy. On this point we equal the English. The manufacture of crown glass was

behindhand with them until the last few years. It has since made great progress in consequence of the wealth of the consumers, who are willing to pay a high price for the article, and of the services of some Frenchmen, who brought from their side of the Channel the processes used in that country. Twenty years since, for instance, window glass was only manufactured round, and from these round plates the panes were cut. It was in 1832, that M. Bontempts, of Choisy, taught the English to make it by the cylindrical method. M. Bontempts again leaving France after the revolution of 1848, established himself in England, where he superintends the works of Messrs. Chance, of Birmingham, and it is under his direction that all the glass for the Crystal Palace was made. It is made in panes 49 inches long by 10 inches broad. They measure altogether about a million square feet. In the agreement entered into with the contractors of the Crystal Palace, it is calculated at *3d.* the square foot. In order to obtain this great superficies, it was necessary to make three or four times the quantity. The choicest kinds were reserved for the rich, who will pay a high price for it, and the inferior will suit the purposes of the poorer customers; the medium quality has been used for the edifice.

With regard to flint glass, the English manufacture the white in a superior manner, and give it a very fine polish. Their white candelabras are very striking and brilliant. The house of Osler, of Birmingham, who made the crystal fountain placed in the grand nave, and the house of Richardson, of Stourbridge, make a very distinguished figure at the Exhibition. In coloured flint glass we have the advantage; our patterns are more elegant, and our colours more brilliant and better assorted. Our mechanical processes, in the manufacture of these articles, are superior to those of the English, and enable us to contend in foreign markets even with

Bohemia, although manual labour is there very cheap. And again, Bohemia makes crown, and not flint glass; the latter, as is well known, is distinguished by the lead which forms part of it (in the state of silicate). The proof of our skill in this manufacture is, that we send our flint glass as far as Hamburgh; if I may use the expression, in the very beard of the Bohemians, who are close at hand. Unfortunately, our manufacturers of Baccarat, and of St. Louis, conceived the much to be regretted idea of not appearing at the London Exhibition. They have thus deprived French industry of one of the surest means it possessed of attracting attention, and the opportunity of increasing their connexion abroad.

With regard to plate glass, we stand the first, so far as regards articles of a certain beauty and magnitude. Our establishments of St. Gobain, St. Quirin, and Montluçon, are the masters in this difficult art, from the moment we come to large articles. St. Gobain and St. Quirin have prosperous depôts in London and at New York. To the manufactory of Montluçon the public owes a debt of gratitude, for having attempted to introduce competition in foreign markets, where a monopoly was previously enjoyed. The manufactory of Montluçon was the only one which had exhibited at the opening, and even pressed for time to appear on the 1st May, it resigned itself to send, among other interesting articles, a large plate glass which is evidently defective. Certainly is would have exhibited a finer piece of workmanship, if it had had time to have recommenced it. St. Gobain decided in July to exhibit, and presented some of the fine plate glass which it has long been in the habit of making. For pieces of smaller demension, where it is not necessary to have so fine a water, and for plate glass for shop fronts, the English, on the contrary, have the advantage. It is an article which is sold at a very low price in London in comparison with Paris.

The house of Chance, and some others at Birmingham, who only make plate glass properly so called, for they cast nothing, manufacture crown glass of the same kind as window glass, which is polished, and which answers well for picture frames. I have been informed that they make 15,000 square feet a week.

I might pass in review many other branches of industry, some mechanical, and others chemical. I might take, for instance, acids and salts, flour and everything connected therewith, and fire-arms, and almost everywhere it would be seen that, between France and England, the superiority oscillates from one to the other, like an object which is suspended in the air, and moves to and fro with the wind. In the same branch of industry one of the two nations surpasses the other in one class of articles, but is excelled in its turn in another. By turns each is the inventor of a new process, which the other brings to perfection. Grinding machinery is a curious example of this. In France, a mill on the English plan is synonymous with an improved mill, which does not, however, prevent the French grinding from being now superior to the English. The English millers loudly proclaim this, and the English protectionists, in their complete defeat, endeavour to make a weapon of it, *telum imbelle sine ictu;* so much so, that it is the French who have supplied the plans of an enormous mill, of 100 pair of stones, erected, it is said, in London. Another fact of the same kind is furnished by a branch of industry which I have already noticed, that of porcelain.

An English manufacturer conceived the idea of making shirt buttons of porcelain ; such an article seems insignificant, but it is of most extensive use. The inventor took out a patent in the United Kingdom ; but soon afterwards a French porcelain manufacturer, M. Bapterosses, a very ingenious man, produced so great an improvement upon the process of

the English inventor, that the latter renounced the exercise of his patent right, and supplied himself with buttons from M. Bapterosses, which he resold to his countrymen.

Certainly the manufactories of chemical products in England are very much advanced ; nevertheless, it is to French *savants* and manufacturers that we owe the fabrication of white of zinc, which is substituted for white lead in house painting, to the great benefit of the human race. The contact of white lead was a poison for the workman. We furnish the finest white of zinc in all the markets where it is required. M. Leclaire of Paris, and M. Lhuillier of Grenelle, have exhibited at London some very remarkable samples of it.

For watch and clock work, and mathematical instruments, England is renowned, and she merits to be so ; France is not less so. The foreigner who wants a good watch, hesitates between the two sides of the Channel. He will prefer taking his ordinary engineering instruments from the English, he will there find them more solid, more portable, and more convenient ; but he will come to the French for a chronometer or a theodolite. The calculating rule, which is in such common use, is much more general in England than in France ; it is in the hand of every English foreman. It is not the less true, that of all the models, the most simple and the most convenient is that of our countryman, Colonel Morin. The English admirably excel in nautical instruments, apparatus, and arrangements ; they fit out a vessel at Portsmouth in one-half or a third of the time that we should take to do it at Brest or Toulon ; but our models are considered better than theirs. For distilling sea-water without expense, with the superfluous heat from the kitchen,— a valuable invention, which dispenses with the necessity of encumbering vessels with a large supply of fresh water, — the

best apparatus is that of M. Rocher of Nantes, before which the ungrateful public walked in the Crystal Palace, without honouring it with a look. For several years past, in order to shorten the period of voyages, the English, who, after the Americans, are, of all people, those who best know the value of time, seek simple and practical means: a system of charts, for instance, with which a captain of a vessel may always keep himself on the great circle of the earth which joins the point of departure to the point of arrival; for from one point to the other of the globe, the shortest distance is the arc of a great circle which unites them. Among these inventions, all more or less ingenious, the best, the most correct, and the most sure, appears to me, the double planisphere of one of our hydrographical engineers, M. Keller.

I should never finish if I attempted to cite here all the facts which demonstrate the industrial advancement of the two nations, and how great a desire they manifest to give to the useful arts, each in its own way, an extraordinary impulsion. There are, however, two discoveries which ought not to be omitted, for they are both extremely beautiful. The one is that of Mr. Baxter, an Englishman, who has discovered the means of colouring engravings by the process of printing. Beautiful prints produced in this way are sold, and even portraits, which appear to be executed by the most delicate pencil. The other is that of M. Masson, a Frenchman, gardener of the Horticultural Society of Paris, who preserves vegetables by desiccation and pressure, so as to make the seaman attacked by scurvy, and the soldier who has to carry a week's provision in Africa, bless his name. Thanks to M. Masson, these individuals may henceforward have daily, in the middle of the ocean, or in the centre of the Desert of Sahara, their rations of fresh vegetables. Dried by hot air, and then submitted to the action of an hydraulic

press, the vegetables which compose, for example, a soup *à la Julienne*, lose seven-eighths or nine-tenths of their weight, and are reduced to a very small volume. A cube yard of Julienne soup, thus prepared, makes 20,000 rations. The man who receives the bulk of a quart of it, has sufficient for twenty days, and, in this state, it is preserved uninjured for years.

In this struggle, in which each, by turns, gains the advantage, each of the two nations, nevertheless, retains its own peculiar genius. The genius of France is taste. This is why, in presence of the figured silks of Lyons, the choice ribbons of St. Etienne, the paper-hangings of Mulhouse and of Paris, articles particularly called Paris articles, and of twenty other various productions, the English, with very good grace, admit themselves to be beaten. This is why, in going through the different sections of the Exhibition, it is found that, out of the French quarter, the majority of the articles which require taste are eclipsed by ours; some of them are frightful, and the least that can be said of almost all the others is, that they have a provincial appearance. In jewellery, for instance, what treasures have not the English exhibited! They have there, in value, I know not how many millions. But our jewellery may nearly always apply to theirs, the expression which Zeuxis used to his rival: "*Not being able to make it beautiful, you have made it rich.*" And our bronzes for furniture, at what a distance do they leave every other behind! The Paris manufacturers of bronze fill the half of one of the compartments of the Exhibition. Our ornamental furniture, thanks to the taste of our designers and of our workmen, leaves every other far in the rear. MM. Fourdinois, Barbedienne, Krieger, and Ringuet, all of Paris, have exhibited the most attractive articles of this kind. The grand sideboard of M. Four-

dinois, which presents statues representing the four quarters of the world, supported by four dogs of large size, is a piece of furniture that would ornament a museum. The cabinet-making, even of the departments, is very beautiful; witness the articles of M. Beaufils of Bordeaux. Taste, therefore, is our distinctive characteristic as compared with the English, and with all the other nations who have exhibited their productions at the Crystal Palace.

The English excel in the general adoption of mechanical means, in the application of metals, especially of steel and iron, often in the practical, commodious, and comfortable side of things, and more frequently still by the skilful intervention of the immense capitals which they have had the talent to amass. It may be said of the French that they carry on their manufactures in an artistical sense; the English do it as dealers who seek a result, who think less of the beauty of their productions than of the balances of their ledger. The Englishman is much more of a merchant than we are; he is merchant to the very tips of his nails, and it is to this circumstance that must be attributed, in a great measure, the success of their manufacturers. It is thus that the English attentively consult the tastes of their customers; they give to their productions the form, the colour, and the magnitude which suit the people whom they wish to supply. The French more particularly consult their own fancy. The instinctive *penchant* of the French will be to improve the quality of their productions, even were they to lose in cheapness by so doing; the English, as from the effect of their temperament, will constantly endeavour, on the contrary, to produce at the lowest possible price, even were the quality to suffer by it. Hence, for instance, those cotton goods, at an incredibly low price, which England manufactures for exportation. These are sold wholesale,

finished and printed, at *2d.* per yard; but for use, they are not worth even the little money they cost.

These characters are not at all absolute; they are only relative, and they admit of many exceptions. It would be extreme injustice to say that the English always show themselves to be wanting in taste. I have found the most exquisite taste in the services of porcelain and of fine earthenware of Minton; in the flint glass of Osler and of Richardson; in some of the silk goods of British manufacture, particularly in China crapes, which are now beautifully made in London. There is much taste in several of the printed goods of Messrs. Schwabe of Manchester; in some of the silk articles of London; and very much in that quarter of the Exhibition called the Medieval Court, where a skilful artist, Mr. Pugin, has collected a number of ornaments in the Gothic style, intended for religious edifices. It would, therefore, be great imprudence, and a presumption which would soon be fatal to us, to believe that we have a monopoly in taste; it is a privilege which we did not enjoy two hundred years since, but which we have since acquired, and which we may lose if we neglect ourselves, and which others may acquire by their efforts.

It will perhaps be said, that the taste which is displayed in a part of English industry has emanated from France; that the elegant articles of English jewellery are from M. Morel, who is a Frenchman, and whom the revolution exiled to London; that Mr. Minton has two French modellers, who were expatriated in 1848, M. Janet and M. Carrier, and as director of his works, another Frenchman, M. Arnoux, another victim of the revolution of 1848, and who, until that period, was managing his own establishment at Valentine (Haute Garonne); that Messrs. Schwabe are Germans by birth, and that their pattern drawers are Frenchmen, — Frenchmen even

residing at Mulhouse and in Paris; that Mr. Pugin himself is the son of a Frenchman, and moreover a pupil of French masters. All this is true; but is it less true that we ourselves have received our taste from others? We are indebted for it to others, and chiefly to the Italians. A few centuries since our taste was very coarse. Our princes drew hither Italians and Flemings, and founded schools. We have cultivated our dispositions; however little apparent they might be, and however latent they were, they have been rendered brilliant. The English do what we have ourselves done. Our artists and our men of taste go to them; the latter driven by the terrible storm of revolutions, and the former seduced by the hope of gain in so rich a country. Schools of design are increasing on the other side of the Channel. The most magnificent objects of art, the statues of all ages, the paintings of all schools, fill the galleries of the great English lords. You will see the result in a few years. And why then are the descendants of Canute and of Front-de-Bœuf more incapable of becoming men of taste than the sons of Brennus or of Clovis?

It will not be more difficult for me to demonstrate that we are not wanting in those aptitudes by which English industry more particularly recommends itself, and that we ought to cultivate them in order to increase them. We are already skilful mechanicians, let us become more so; let us make a more general application of machinery; let us introduce it into agriculture, in which the English have performed such wonders with it. We are not bad metallurgists; let us cultivate more and more that branch of the arts, and for that purpose let us open our ports to raw foreign metals which are cheap. We are not without some glimmerings of commercial genius, and continued efforts will make us rivals of the merchants of London, of Liverpool, of Hamburgh, and

of Rotterdam, and our manufactures and our agriculture will soon feel the effect of it. Nothing is to be done here below without labour, with it everything may be accomplished. Let us not forget, that if one of the aspects of civilisation is to distribute industry, in diversifying it among men and among nations, it is also the proper characteristic of civilisation to multiply in each people special vocations, and to develop there every kind of talent.

I would not, however, have it believed that I consider France and England as concentrating in themselves everything that is great in European industry. Other nations besides them appear with the greatest *éclat* at the Exhibition. Belgium, Saxony, and Switzerland are very far advanced in the useful arts; they follow very close on England and France. Prussia is in manufactures, as in letters, in sciences, and in the fine arts, a power of the first order. The Prussian Exhibition presents, in more than one particular, the proof of very advanced taste, and the finest pieces of steel in the Exhibition come from the establishment of a Prussian, M. Krupp, whose magnificent cuirasses, which are interdicted to our brave soldiers in consequence of the system of commercial policy which governs us, were lately spoken of by M. Hovyn-Tranchère, an intelligent member of the National Assembly. Europe is one by industry, as it is by opinions and by sentiments. The nations to which the name of great powers is given, and which bear that title by universal consent, owe it less to the number of their bayonets than to their enlightenment and the solidity and *éclat* of their genius. What, therefore, is industry, if it be not a manifestation of the human mind, and the domination exercised by mind over matter?

LETTER VIII.

CONCLUSION.

No, this age is not servilely devoted to the worship of matter. The civilisation of Europe has been accused of having fallen into the slough of materialism, and of sinking every day still deeper in it. This is an extreme injustice. Certainly there are, in our day, corrupted and avaricious individuals. Alas! all vices are common in all ages. It has come within the designs of Providence, as everything teaches us, that men should be incessantly warned of the fragility of their nature, by examples always afflicting, and sometimes hideous. If, at certain moments, materialism has appeared to spread itself over the social body like a furious leprosy, these moments have been short, and they also offered the striking spectacle of devotedness and virtue. If there was licentiousness in France under the Directory, is it to be thence inferred that there was no disinterestedness and heroism in our armies, that our magistracy was not pure, and that the people despaired of liberty? Because the Jewish people worshipped the golden calf during the few days that Moses passed on Mount Sinai, has it been ever said that idolatry was their worship after they quitted Egypt?

No, the age is not marked by materialism as by the seal of the beast. Taken in its *ensemble*, and observed in its most general and most salient characteristics, it is more spiritualist than any of the ages which have preceded it. I find the proof of this written in indelible characters on the greater number of the pages of contemporaneous history. And what

then are the advantages in the pursuit of which civilisation has hurried on for the last sixty years? What is the device that it has inscribed on its standard? What are the words which have had the power of electrifying men's souls? Is it the paradise of Mahomet, the voluptuousness of Sybaris, or the lnxury of Heliogabalus, that the generous minds in whose steps the human race has followed, have promised to men? Can it, in good faith, be maintained, that it is to satisfy coarse appetites, that France has, since 1789, shed her blood in torrents, and lavished her treasures, and that everywhere throughout Europe the people for the last sixty years have addressed to heaven their ardent prayers, and multiplied their efforts with untiring perseverance? I have listened in vain to the imposing clamour which proceeds from the bosom of nations; constantly the words which dominate over all the rest, and to which myriads on myriads of voices serve as the echo, are appeals to liberty, and claims for justice, under the name of equality; and what imports it, that, in the midst of this majestic choir, some individuals should murmur forth some sensual hopes? It is for justice and liberty that Europe agitates herself, and that the world is in labour. That the labour may be painful I dispute not; for pain is its necessary attendant. But justice and liberty, those sovereign benefits which more than ever excite the transports of men, these springs of joy and grandeur, at which civilisation wishes to quench its thirst at the price of a thousand evils and the hardest sacrifices, and which she is at length on the point of attaining—is all this, I ask, material substance? I beg to be told the specific weight, the colour, and the taste of it; and I call on the ultra-Christians, who erect themselves into a tribunal from which there is no appeal, and pronounce against the age these uncharitable judgments, to inform us whether it is not, on the contrary, the groundwork of Chris-

tianity, and the commencement and the end of that august religion.

No, the age is not materialist, although some of its children may be so. I see a striking demonstration of this in the very fact of this Universal Exhibition; which is, nevertheless, devoted to the glory of the arts, by which man acts on matter and appropriates it to his wants. The Universal Exhibition is nothing less than the bringing together of all the nations of the earth on one ground, where national hatreds may be effaced, without the genius peculiar to each being enervated.

The sentiment which was nobly expressed in the speech of Prince Albert, has been repeated in twenty other speeches to which the Universal Exhibition has given rise. It was more particularly found in that delivered by Lord Ashburton on the 20th May, 1851, when he presided at the banquet given to the Foreign Commissioners of the Exhibition at Richmond. This sentiment is thus constantly on the lips of English orators, because it is in the heart of the English nation, and because it is also felt by us and by all Europe. It is not, therefore, an ephemeral fruit, nor a phraseology invented for the occasion. It is an idea the germ of which is old, like the Christian religion; for that has always taught us that all men are brothers, being all children of the same God. But this germ has become a magnificent tree, the fruit of which has, in our day, arrived at maturity. The sentiment of the unity of the human race, on which Prince Albert and Lord Ashburton insisted, is the same which has been so often cried up under the name of the fraternity of nations. It is this which Beranger has sung under the name of the *Holy Alliance of Nations*. As we are now sufficiently removed from the events, so disastrous for us, of 1815, to render it possible for a French-

man to be just towards all those who took part in them, without exciting a painful feeling of surprise around him, I may add that it is the same as the Emperor Alexander, under a form peculiar to his mind and position, pursued when he organised with ardour a Holy Alliance of Governments. Some years further back in our history, this same sentiment gave birth to the scene where Anarcharsis Clootz, *the orator of the human race*, pompously harangued the Convention at the head of a group of personages of every country. But the London Exhibition is advantageously distinguished from all the manifestations which have hitherto been made of this great and fruitful idea. The ceremony in which Clootz celebrated, in a declamatory tone, the fraternity of nations, looked like an insult to good sense, because we were then at war with the whole of Europe. After 1815, the Holy Alliance of Governments became almost immediately a league against all liberal ideas; and the Holy Alliance of Nations, extolled by the Tyrteus who consoled France for her reverses, tended to organise a campaign of people against sovereigns. The Exhibition came at its point and at its hour. Everything was at length ripe for the accord of all the civilised men in the world to reveal itself with *éclat*. Thirty-five years of prosperous and fruitful peace had effaced all distressing reminiscences, and there was at length discovered a neutral ground where the old quarrels which divided nations could not find a place — that of labour, where the domination over nature by the human mind, for the common welfare, common independence, and common dignity of mankind, was displayed.

I must here be allowed to make an observation on the character of our general policy. We are proud of being Frenchmen, and the world, in its days of equity, feels for our country an admiration blended with gratitude, because

France had contracted the habit of taking fact and cause as the great principles of civilisation. She has considered and treated the affairs of the human race as her own. She has been the heart of the world, and her beatings made themselves felt from pole to pole; the events of 1848 loudly attest this fact. She has lavished the life and patrimony of her children to support the honour of her ideas. She has sometimes violated equity or abandoned herself to the inspirations of an arrogant policy; and it has even happened that she has outraged good faith. What would we not now give to be able to tear from our annals the overbearing conduct of Louis XIV. towards Holland, or the scenes at Bayonne between Napoleon and the Spanish princes? But, even in her outbursts and her errors, the foreign policy of France has almost constantly testified a great respect for humanity; and this policy has always distinguished itself by being sympathetic. It has been sometimes railed at, and styled sentimental and humanitarian. But I do not think that any policy can be great, if it is not in accordance with the general instincts of humanity; and I do not know of any nations or individuals who have ever effected anything great or durable, unless they had been animated and supported by a good and elevated sentiment. It happens that England has, for some time past, taken a very ample part in that noble initiative which appeared to belong to us, and which the assent of the human race recognises among our attributes.

The element which an egotistical and weak philosophy has called by a name, but which, however, I accept,—that of *humanitarian*,—has made for itself in British policy a place which one had not been accustomed to see there. Formerly England, as if to justify the expression of the classic poet, kept herself in her plans apart from the human race. She had an insular policy. For some time past this

has been changed. Look at what she has done during the last twenty years. She wished to enfranchise the slaves, and she has accomplished it with that calm resolution which is the glory of the English character, and which gives to English policy so much consistency. The slave-holders were largely indemnified at the cost of twenty millions, and the emancipation was effected in her colonies; and it is a cause which has now gained ground in the world. Afterwards, taking in hand the cause of humanity in favour of the African negroes, she recognised and accepted the right of search, against which a spurious patriotism raised such an outcry with us; a right which was in no way humiliating for either of the two nations, since it was perfectly reciprocal. At a later period, when England concluded a treaty of peace with China, she therein stipulated that the Celestial Empire should renounce the state of isolation in which she had before placed herself; and she stipulated this, not for herself alone, but for every nation without distinction. If, at the same period, the French Government, placed under similar circumstances, had acted in the same manner, and had abstained from reserving to herself particular advantages for her national commerce, violent complaints would have been raised against her. She would have been attacked in the press, and it would have been repeated in the national tribune that she had sacrificed the interest of the country to foreigners; and, wretched as the charge would have been, the pretended patriotic accusation would have obtained credit with a great majority of the public.

The Universal Exhibition of London, or, to speak more correctly, the commercial system connected with it, has the same tendencies, but more strongly brought forward. Contrary to the spirit of Christian civilisation, the old commercial system amongst the English, as well as in the rest of

Europe, was founded on the system of hostility of one nation to another. It was admitted in principle, that in commercial matters, the profit of the one constituted the loss of the other, as was said by Montaigne: a notion, however, which is materially false; for when two parties, freely contracting, exchange their merchandize, it is fair to suppose that each finds his advantage in so doing, and that, in fact, each finds in it the means of best satisfying his wants. When two nations freely exchange their productions, they enrich each other, for he is enriched which acquires the means of satisfying his wants. And by what combination of circumstance can a transaction favourable to both parties when it takes place within one state, and between two individuals belonging to that state, cease to have that character when it takes place between different nations? The old commercial system which England abjured in 1846, suggests to each nation this singular pretension, that she has sufficient for all her wants, but that she could furnish much merchandize to foreign countries; as if these terms were not contradictory. In fact it is nonsense, an impossibility, and an hallucination; for if the system is in vigour in France, if we proclaim it excellent, is it not recommending our neighbour to apply it also? When I exclude the merchandize of another nation, in boasting of thus having found the means of enriching myself, do I not induce him to exclude mine? Moreover, I cannot sell him mine without purchasing his. The rule is absolute. Gold and silver themselves, when they enter *de facto*, and not merely nominally into transactions, make no infraction of it; for these two metals, whether coined or in ingots, are merchandize, like lead, or copper, or iron, or like any other productions of industry, and each nation only requires them in a certain proportion as compared with other merchandize.

Negotiators, however, endeavoured, by every means in their

power, in the bargains which they made, to sell without purchasing. They were necessarily defeated by the force of circumstances, and it was very fortunate; for in order to succeed in this strange programme, it would have been necessary that those to whom the sales were made, should become bankrupts. I defy any one to point out any other means of arriving at the plan of selling without purchasing. And, nevertheless, I could quote administrative or parliamentary documents of the most recent date, in which some parties in France pride themselves on having solved this fine problem, of selling abroad and skilfully avoiding purchasing; and this absurdity finds admirers.

In 1846, the English Government, through the organ of Sir Robert Peel, repudiated this isolation, which was pretended to be crafty, but was in reality silly. He admitted that the purchaser is not the victim, or, as he is called in protectionist language, the *tributary* of him who sells, any more when the transaction takes place between an Englishman and a Frenchman, than when the two parties are of the same nation. He understood and proclaimed, that the interest of all nations, as well as of all individuals, was to come to an understanding and concert together for the purpose of satisfying their common wants, each furnishing that which he most excelled in, and stimulating each other by mutual competition; an idea eminently favourable to the majority for several reasons. It supposes the peace of the world, and it is the masses on whom falls the heavy load of war. From the very fact of its supposing peace, it prepares and will determine the suppression of the exclusive privileges with which certain classes have been formerly invested, in view of the necessities of war. War was formerly the ruling hypothesis in the policy of all governments. The new rights which have been called into being by the progress of civilisation, require peace.

England, by the commercial policy which she has started, has replaced the hypothesis of war by that of peace. A nation who, not content with adopting for the first of its manufactures cotton — of which the raw material is derived from regions far beyond the seas — counts upon foreign corn for its sustenance, erects itself by that very fact into a defender of peace; it obliges her to wish for the concert of nations. It becomes a necessary partisan of fraternity of races, and of nations. It closely unites its cause to the maintenance of Christian principles. Is this, I ask, materialism? Does an age or a nation which gives such an example, and to which all other nations, whether willingly or unwillingly, prepare to conform their laws, live in the lowest depths of a sordid materialism?

In the internal policy of states, the idea, the development of which led to the Universal Exhibition, has introduced a progress not less beneficent, and the morality of which is not less striking. Under the feudal *régime*, nations were divided into small groups, who fortified themselves one against the other. The lords guarded themselves in their vultures' nests, with their men-at-arms. The commoners, the cradle of the *tiers état*, surrounded themselves with walls and towers. The corporations of arts and trades had around them, as a protecting barrier, the monopoly which was recognised by the law, and they maintained the prerogative of it at great expense before the parliaments. Times sadly whimsical; a tissue of contradictions which would be inexplicable, if we did not see in it a necessary transition between the *régime* founded on the absolute subjection of the great number, and the era of liberty.

Finding the world around it divided into small brutal sovereignties, into a thousand exclusive privileges, and into jealous jurisdictions, the genius of liberty was then compelled

to place herself under the auspices of privilege and of monopoly, and the *tiers état* organized itself in consequence. Hence a multitude of abuses and of inequalities which in our time could not be justified, and the greater part of which the current of civilisation has already swept away, and shaken the rest. All that was condemned and virtually abolished on the day when the eminently salutary principle of common right — a principle of the highest morality, for it was equity itself — was inaugurated. The idea of common right has become the foundation of the public law of civilised states at home. No one can withdraw himself from it. All that is opposed to it is destined shortly to perish, and it is for that reason that the protectionist *régime* cannot much longer exist with civilised nations. It is in vain that it assumes a threatening attitude, its airs are more worthy of pity than of anger.

Common right cannot, in fact, accommodate itself to the privileges which display themselves under the standard of protection. When once the principle of common right had entered into our habits, it was inevitable that we should ask ourselves whether it were lawful for the State to interfere between certain classes of producers and the public consumer, in order to compel the latter to pay to the former, for their merchandize, more than it was worth in the general market? The question, in fact, was raised from the moment when the principle of common right, or, what amounts to the same thing, equality before the law, was proclaimed. The men of 1789 were strongly opposed to the protective *régime*, and in favour of free trade. What fine remarks were those written by Turgot, who was their friend and master, in order to advocate the cause of commercial freedom against those private interests which pretended that they were the personification of national labour! The proceedings of the

interested parties, and the national prejudices, raised to the highest pitch by the inveterate wars of the French revolution, had, for a time, made the balance lean on the side of the protectionists; but, in 1838, the discussion was resumed with vigour in England, and it was done in a manner which well justified the proverb — " A question well put, is more than half solved." Is it just, exclaimed some generous-minded men, that the public should pay dues to others besides the State, to others who, in the eyes of the law, were nothing, and did nothing, more than the rest of their fellow citizens? A momentary assistance to necessitous men, a temporary subsidy to men who tried their strength, was a social expediency; but a permanent tax, and an indefinite tribute to men who pretended that they dispensed without paying a tribute to the foreigner, is incompatible with modern civilisation. It is necessary that this should disappear, and take its place in the dust of the tombs with the other institutions of the past, which might formerly have been indispensable, but which, in our days, are repugnant to equity and good sense.

No sophistry or paradox can overthrow this argument. It is a glory for England, it is a proof of the reason of that nation, and of the strength which the sentiment of equity has there acquired, that she was the first in which, before that claim (which was, it must be allowed, supported with much vigour and considerable talent), all opposition, all the coalitions of private interests, and all the intrigues of parties were compelled to give way. The interest of the aristocracy itself, all powerful as it was, was obliged to bend and submit itself. This triumph of the principle of common right realised itself with a mass of attendant circumstances, which showed what progress public opinion had made, and how much it had released itself from the hateful prejudices with

which patriotism had formerly nourished itself. The word foreigner was synonymous with that of enemy. The neighbouring nations were hated, not only in their armies and in their persons, but even in their manufacturing products. In the heat of their real or pretended passions, political men, who hunted after popularity, included in their maledictions all that the foreigner might manufacture or derive from his soil. The idea of a foreigner reaping any profit by his relations with one of their countrymen, made them start with horror. It was of little consequence to them that their countrymen also had their share of profit; the foreigner derived an advantage, and that, in their eyes, was enough to make them condemn it. The English, when they returned to free trade, have placed themselves above this disastrous error. Their statesmen have not sought to measure what the foreign nation would gain by England purchasing its productions, they did not wish to look at that; they saw that the consumers, that is to say, the mass of the people, would derive an advantage, and from that moment their decision was taken. They proclaimed the principle of free trade, and they have applied it without demanding reciprocity from any one. Before 1846, when the protective system was accredited in the councils of their government, they had opened negotiations in which they offered to lighten the conditions of admission for some foreign productions, provided an equivalent advantage were granted to English articles. On this occasion nothing of the kind has taken place; no negotiations have been entered into on the subject. The foreigner was left to his free will. If, they said to themselves, he will not enjoy the benefits of liberty, let him commit the fault; let him continue to exclude the merchandize of other countries; let him in this manner impoverish his people, and lessen their welfare, if such be his

good pleasure. Let us respect his liberty, even in his aberrations; but we will not make our intelligence subservient to that of our neighbour.

England has reaped the harvest which she sowed. She has passed through the last period of revolutions without receiving any shock. The Continent has been shaken to its very foundations, England has been exempt from the slightest shock. She offers to other nations a model worthy of imitation, and, confident in their good sense, they do not deign to perceive that rhetoricians, like the serpent in the fable, which exhausted itself by biting at a file, use their eloquence in vain efforts to turn that majestic reform into ridicule in the eyes of their fellow citizens.

From the character and the direction which she has given to her foreign and domestic policy for a certain number of years past, England has taken a high rank in the mind of the friends of humanity, and of the partisans of exalted principles. She does not draw up preambles of constitutions, in which she boasts of serving as an example to all other nations, she does better; she takes the part of *coryphée*, which she finds vacant, and leaves us in the rear with our boastings. It gives me a bitter pang to see my country thus thrown into the second rank; but I hope that, once more restored to good sense, she will not delay to dismiss the flatterers who abuse her, and will bring herself rapidly to a level with her old competitor. In ideas and general sentiments, France is well advanced; it will not be difficult for her, if she wishes, to overtake any nation whatever; for it is the advancement of sentiments and of ideas, that it is to say, moral progress, which determines progress of every kind, and in the practice of industrial arts she has proved, at the Universal Exhibition, that she fears no comparison with any one.

LETTERS OF M. JOHN LEMOINNE.

LETTER I.

London, June, 1851.

If I remember rightly, it is Jean Jacques Rousseau who affirmed that he would rather be accounted a man of paradoxes than a man of prejudices; I hold the contrary opinion. There are amateurs of paradoxes, who come to London *not* to go and see the Exhibition. I was so prejudiced as to go there on my arrival, and was still more prejudiced, in common with many others, by being overwhelmed with admiration at the marvellous spectacle. This sentiment is universal. I hear it on all sides, and in all languages. There is no spirit so critical or sceptical as not to bend before this vast display.

Independently of the difficulties opposed to the mere execution of the enterprise, there was a certain feeling of hesitation in the public mind as to its result. The effect of its opening was regarded with a certain misgiving, and the first month produced a degree of disappointment among the Londoners. The hotels were scarcely fuller than usual. The lodging houses exhibited their melancholy bills, and the innumerable preparations made to receive the whole world seemed as though they had been made in vain. So much had been said in anticipation of the millions about to pour into the great metropolis from the first day, that vast numbers

were alarmed rather than attracted, and paused to hear the result of the opening before venturing to come. It had been imagined throughout Europe, that it would be impossible to move in the streets; that persons would be compelled to sleep in the open air, not a very agreeable anticipation, considering the opinion generally entertained of the climate and atmosphere. It soon appeared, however, that these were exaggerations. By degrees our fears were removed, and when it was discovered that everything went on in the most quiet and regular manner possible, the visitors commenced their journey; and now from the most remote parts of the Continent, and the shores of the most distant seas, numberless caravans come to plant their tents around this great mart of the universe. It is like the movement of the ocean, one wave following another. The tide has been slow, because its point of departure was distant; but once in motion it will not cease. This pacific invasion of all nations has changed the aspect of London. In this immense city, which has no barriers, still less fortifications, and which is an aggregation of small towns and villages which have grown into one another, and have at length coalesced and formed the great metropolis, the presence of foreigners is, in general, rarely observable. At present, however, one's ears never cease to be struck with all dialects, known and unknown. From the Chinese true and false, to the serfs of Russia, all races are represented, and are walking about in all costumes, to say nothing of the beards and moustaches, which here in England are still a foreign garbment.

The English have on this occasion abandoned their usual habits. In very truth, I think they are becoming social and familiar. They have been always polite and hospitable to those who bring proper introductions to them, but now one actually meets some who enter into conversation without

that preliminary condition. Decidedly, British manners are altered. This exceptional conduct arises, however, from an excellent sentiment, — the English are now offering hospitality to the whole world, and they pique themselves on receiving it graciously. They are desirous, too, that the highest idea should be formed of their national grandeur, and they question you with evident solicitude on the impression produced by the inspection of the Exhibition.

This impression, it must be admitted, is very grand. You feel it even before you reach the Crystal Palace. As on a journey you recognise the approach to a great city by the perpetually increasing number of persons you encounter on the road, so in the movement which is accelerated and increased on the road to the Exhibition, you recognise the approach to a great centre of attraction. I here notice only the simple impressions of the spectator or the tourist, but I can easily conceive the effect which the sight of Piccadilly, Hyde Park, and that great road which leads to the Crystal Palace must produce on strangers. It is an inconceivable bustle which defies all description. The uninitiated traveller is absolutely bewildered. The passing and repassing of horses and carriages seems like the crossing of several trains on a railway. It is indeed a *mêlée*, which, when seen for the first time, leads one to fear that the result will be collision and a general upset. We are quite surprised to see nothing overthrown, nothing broken, and that all these carriages make their way out from one another, as if they were of gutta percha.

The multiplication of omnibuses especially, seems fabulous. They may be counted by hundreds in a quarter of an hour. The best method of seeing in this country, and at the same time the most democratic, is to mount on the top of an omnibus. From thence you have a view of the whole route, and

this astonishing palace of glass may be seen long before reaching it.

Nothing can be more striking than the first view of the transept. Facing you is a large tree, which has been placed, as it were, under a bell, like a plant. Advancing, you make the tour of this immense dome, amidst verdure and flowers, the murmur of waters, and encounter, at the other extremity, two other large trees, likewise enclosed in this prodigious glass case.

Imagine now 50,000 men, women, and children walking about in this vast greenhouse, without the least tumult or disorder. On the days on which the price of admission is one shilling, about 70,000 persons sometimes visit it. There are two days on which the price is higher; on Friday half-a-crown is paid, and on Saturday five shillings. Saturday is the fashionable day, and as the palace is not closed until seven o'clock, Albion may be seen from four to six in all the *éclat* of her beauty. The shilling days are not less curious. These are the days for country people, who arrive in their rustic dresses, with their wives, their children, and provisions. The railways bring them to London at reduced fares, and at the station they take large waggons, which bring them to the Exhibition. Caravans full of them are thus encountered in the streets. Whole parishes sometimes come, headed by their clergymen. The colonels of regiments send their soldiers, and the admirals their sailors. Not less worthy of observation are the hundreds of charity children, in their blue dress with yellow stockings, that are frequently met marching in rank and file. About two or three o'clock every one eats, and takes his *luncheon*.

There are several buffets, where there are all kinds of fearful pastry, and horrible creams that would be ices. The prices are fixed by the Committee, and marked up. No

wine, beer, or spirits are allowed; but of course there is tea. There are, besides, interspersed in the palace, several fountains of filtered water, ornamented with small drinking cups, at the disposal of the promenaders.

Saturday morning, until twelve o'clock, is reserved for the infirm and invalids, who are drawn in small carriages, and of these there are a great number.

I have seen the Exhibition also under an aspect which is not void of picturesque, I have seen it on a Sunday.

I should have thought this undertaking impracticable, for here the earth is not permitted to turn on its axis on Sundays, whatever Foucault may please to assert. I did, however, succeed in entering, thanks to patronage which I will not betray. Silence reigned around; the very clocks were still; I believe there was but one going. The statues, enveloped in wrappers, resembled ghosts, and the most precious articles were also covered up. I was particularly struck at the sight of a policeman, quietly occupied with his prayer-book, whom our desecration of the sabbath must have somewhat scandalised.

Sixty years were required for building St. Peter's at Rome. The new Houses of Parliament at London were commenced fifteen years ago, and are not yet finished. The Palace of the Exhibition was begun and finished in three months. Will it live like the roses, only for the season? This is the question of the moment. For poetic imaginations, there would be a certain charm in the destruction of this magical work, which would only, as it were, have appeared on the stage as a passing scene. Cleopatra, indeed, caused the most costly pearl in the world to be dissolved in a cup, and gratified herself by drinking a million at a draught. Why may not a great nation indulge in caprices such as that of Cleopatra?

One of the greatest and rarest curiosities that England

presents at this moment to foreigners, who come to see the Exhibition, is decidedly the sun. I am not speaking of the famous *Mountain of Light*, but the veritable sun in the sky, which diffuses light and heat. For some days London has had a factitious air of Naples. Piccadilly and Regent Street are as scorching as Santa Lucia and the Chiaia. There is, however, this difference, that in Italy the streets are deserted during the whole day, and that here the movement of the population is never for one moment suspended. Some tourists, who have come with the idea that the sun is never to be seen in London, and that people walk about with torches in mid-day, feel actual disappointment in being able to distinguish the dome of St. Paul's. Some there are, indeed, who wish to falsify the proverb, "Solem quis dicere falsum," and who are quite ready to believe that the English have invented some process to warm their climate for this particular occasion. And why not? These Englishmen are so vain, and they have invented so many machines! You may easily imagine that, in such weather, the Crystal Palace somewhat resembles a hot-house. One spends one's time in looking for seats as near as possible to the fountains and basins of filtered water, and in eating those eternal creams, which are something like iced pomatum.

It is more in vogue than ever to go on Saturday morning. You know that the forenoons of Saturdays are reserved for invalids, who are admitted in their wheeled chairs, in which they are drawn about. There are many real invalids, but there are also some false ones, who, so soon as they have obtained admission, like Sixtus Quintus, get rid of their crutches, a circumstance which gives the Crystal Palace a certain likeness with the Court of Miracles.

On Saturdays, one meets regularly Her Majesty and suite, and then the organs play spontaneously, "God save the

Queen." In this country, all instruments play this air in the same way as everything is called "Waterloo," — the streets, the bridges, the omnibuses, the paletots, the boots. Not to be behindhand with the public in politeness, let us leave the Queen peaceably to her promenade, and let us continue ours. It is a mere promenade of curiosity, only a little tortuous, that I ask permission to make. If we would proceed regularly, it would be difficult. We should lose ourselves. The police office is every day encumbered with objects that have been lost, from umbrellas to children. Yesterday, the policemen collected, along with sticks and parasols, half-a-dozen little girls, who had arrived with a "pleasure train." Happily, they were ticketed and numbered as bales of goods, and were marked from "Bristol." After having received lunch, they were taken back to the sheep-fold.

England, as you are aware, reserved half the Crystal Palace for the exhibition of its own products, all the left-hand, on entering by the principal door. This is comprised under the name of the United Kingdom. Nothing can better represent "penitus toto divisos orbe Britannos." With England, Scotland, and Ireland, there are India, Jersey, Guernsey, the Ionian Islands, Africa, Malta, Canada, Nova Scotia, New Zealand, the Bermudas, the Bahamas, Trinidad, Ceylon. The United States of America no longer belong to the mother country. They walk alone, having attained their majority: they are at the extremity of the other nave. On the right are all the nations who have flocked together to this great rendezvous. France is placed amidst Turkey, Egypt, Italy, Spain, Portugal, China, Switzerland, and Brazils.

To the name of France has been added that of Algiers, a sign that they do not endeavour, as heretofore, to contest our conquest, and that they regard it hereafter as a "fait

accompli." The middle of the great nave is occupied by objects of art, disposed with much skill and effect. On the first *coup d'œil* of this avenue, which is one-third of a mile in length, one may form a philosophic idea of the genius of the different nations who figure at the Exhibition. Thus, while the foreign nave is filled with *objects of art*, properly speaking, the English is principally occupied by *objects of utility*.

As I cannot write a catalogue, I pass over the statues and the organs. The capital work of sculpture in this gallery is the *Amazon*, by Kiss, of Berlin. It is an Amazon who strikes with her javelin a tiger which has fastened on the neck of her horse, and is a masterly performance. Something less severe, but more pleasing, is the *Greek Slave*, by an American sculptor. It is not, perhaps, an *ideal* type, but is a copy of an admirable figure. The young slave is placed in a niche in velvet, on a turning joint, and must be a little giddy by the end of the day.

After indulging, contrary to her custom, in a work of art, America exhibits another work which characterises her much better. It is an enormous trophy of articles in *caoutchouc!* It is difficult to conceive anything more ugly, but possibly it is useful. I presume the United States were desirous, by this frightful edifice of india-rubber, to symbolise themselves, and typify the development to which they are destined. Beside this are two of those poor Indians (*Iowas*) whom we formerly saw at Paris, and with whom I remember to have breakfasted. I still remember their air of profound sorrow, which betrayed their nostalgia, and the delight which they exhibited when in a large garden. There is something cruel and ostentatious in the exhibition of these two poor Red-skins. It is nothing but a trophy. They are slaves chained to the car of the conqueror; they are the shadow of the old races that the victorious and implacable civilisation

of the West crushes in its progress. The American exhibition is crowned, at the extremity of the nave, by an immense organ, the pipes of which are ornamented in such a manner that they resemble great penny trumpets or gigantic sugar-sticks.

From American to English art the transition is easy. Both are of the same character, generally prosaic. I should except a very graceful group in marble, representing Venus and Cupid, by Davies; but the rest of the objects which fill the English nave are composed in general of works in which the useful is more prominent than the agreeable. We now have before us a trophy, not in caoutchouc, but in silk. It is the exhibition of home-made manufactures, at least so called; but wherever you find very beautiful silks they probably are from Lyons. After this you see another trophy in Canadian timber, surmounted by a skiff; then another in Sheffield cutlery, consisting of pen-knives with five or six hundred blades, two hundred and fifty pair of scissors of every kind, one of the triumphs of England. Then enormous glasses; then light-houses and improved telescopes; then a trophy in furs, exhibited by the Hudson Bay Company; then models of every kind.

After this excursion in the nave of the Crystal Palace, let us go, if you please, to see the adoration of the relics. On the right, and nearly at the entrance of the foreign nave, you observe a crowd, curious and eager, flocking about a great parrot-cage with gilded bars. Within that is placed on a cushion the *Koh-i-noor.* This diamond supplies, in the history of Central Asia, the place of the golden fleece, and has occasioned more than one bloody war. It ultimately came into the hands of Runjeet Singh; and when, after his death, England annexed his kingdom to its Indian possessions, the "Mountain of Light" was sent to London.

It is now, if not the most curious, at least the most attractive article in the Exhibition. It weighs 186 carats. As to its value, it is necessarily nominal; it may be worth two millions, or—nothing. To ordinary eyes it is nothing more than an egg-shaped lump of glass. They may show us whatever they please, and call it Koh-i-noor. On ordinary days, that is, the shilling days, it is exposed in its great cage, ornamented with a policeman, and they rely on the sun to cause it to sparkle: but on the Friday and Saturday it puts on its best dress; it is arranged in a tent of red cloth, and the interior is supplied with a dozen little jets of gas, which throw their light on the god of the temple. Unhappily, the Koh-i-noor does not sparkle even then. Thus the most curious thing is not the divinity but the worshippers. I have seen a pretty considerable number of relics adored, from the *Bambino* in wax of the *ara cæli* at Rome, to the blood of Saint Januarius at Naples. The adoration of the *Mountain of Light* is quite of the same character. One places oneself in the file to go in at one side of the niche, looks at the golden calf protected by the impassable policeman, and goes out on the other side. If the organs should chance to play at the same moment the illusion is complete.

There is another thing also which has the same effect. It is a fountain of eau de Cologne of Maria-Farina. This is also guarded by a policeman, who takes quietly your handkerchief, passes it across the *jet d'eau*, and returns it perfumed. The Koh-i-noor is well secured; it is placed on a machine which causes it, on the slightest touch, to enter an iron box. It is thus put to bed every evening, and does not get up till towards noon. The procession of the faithful then commences, and only finishes at seven o'clock.

LETTER II.

Let us continue our ramble among the curiosities of the Exhibition. We go to the Crystal Palace on a common day, Monday, for example, at ten o'clock, when you will see the arrivals of the countryfolk and the schools. Four-horse coaches, such as were used before the establishment of railways, carrying four inside and about twenty outside passengers, are again brought into requisition for this occasion. From these elevated vehicles descend multitudes of females in very gay toilettes. Being safely landed, they leisurely arrange their dresses, and re-adjust that prodigious development which betrays the abuse of "crinoline." It is much to be regretted that, in this instance, the efforts of art should not be better directed than in spoiling nature. After these arrive large waggons, with a series of seats, bringing the young folks from the boarding or charity schools. It is somewhat curious to see this general landing. I could never have conceived, without ocular demonstration of the fact, that so many living beings could be packed into so small a space without being suffocated. Out they come, fifty at a time, and when you imagine the vehicle has delivered all its load, out pours a new batch; in sooth, this beats Robert Houdin.

But let us enter. One of the principal advantages of the Crystal Palace is the great number of avenues; there is no necessity of twice treading the same ground. If, by chance, you have left your carriage at one of the extremities, and you find yourself at another, don't be uneasy, you have at command a rapid and intelligent slave, more prompt than

any footman. In passing along the galleries, you may have perceived several small boxes, under the superintendence of little boys of twelve or fourteen years old. These are the keys which govern the wires of the electric telegraph. In a moment you may have your carriage called from one end of the building and sent to any entrance you may desire. The telegraph is, moreover, at your service for communication with all the principal railway stations, and thence with all the principal towns in the kingdom. From the Exhibition you may send any messages you please to Dover, Bristol, Edinburgh, everywhere. The tariff is 1*s.* for twenty words, increasing, of course, in proportion to the distance. A despatch of twenty words sent to York or Edinburgh, costs 8*s.* 6*d.* In addition to this, you may write your letters at the Exhibition, and in the transept you will find a branch post-office.

We will not now stop at the Koh-i-noor, which is still offered to the worship of the faithful. A very good imitation of this jewel, in pure crystal, has just been made. The original and the imitation resemble each other as closely as two drops of the clearest water. The two Sosias were not more like. It is said that the Koh-i-noor is only half its original size, the other half being in its native country, where it has been found in possession of an honest "prolétaire," who made use of it as a flint to strike a light. This anecdote, which was related the other day at a meeting of *savans*, appears to me full of philosophy. I am no less interested by a drawing which represents coalheavers contemplating the huge block of coal, which decorates one of the entrances to the Exhibition, and exclaiming, "This is the real diamond!" It is, in truth, the real diamond of England; and, after all, it seems that the other itself is but a species of coal. Never mind, however; all the philosophy in the world will not

prevent the diamond being the loadstone of the fair sex. Wherever the ladies obstruct the circulation, and crowd one on the other, you may be sure there are jewels exhibited. It is the hardest service of the poor policeman, who dares not behave rudely to the fairer half of the creation, and who, from time to time, exclaims in a voice sometimes severe, sometimes in despondency, "Pass on, ladies — pass on!"

I have told you that wherever there were jewels you would be sure to find a policeman; he is the body-guard of the diamonds and pearls. There is one stationed near the blue diamond, for there is a blue diamond, as there must be, somewhere, a white blackbird. This curiosity forms part of the collection of Mr. Hope; it is a blue stone, weighing 177 grains, and has no marketable value, being unique. M. Bapst, of Paris, has also a phenomenon of this kind, the black diamond. Mr. Hope shows also, as an amateur, the largest known pearl in the world, which is, in shape, like a small pear.

In valuables of this kind, the Indian exhibition is unrivalled. It contains the *Durria-i-noor*, or Sea of Light, a large diamond, estimated at 320,000*l.*; a girdle of superb emeralds, and necklaces of two hundred fine pearls, surpassing all that have been heretofore seen in Europe; a costume of an Indian prince, with two epaulettes in fine pearls; thrones and palanquins in ivory; saddles, mounted with diamonds, rubies, and emeralds; and sandals ornamented with precious stones. There are also some *chefs-d'œuvre* of human industry, a collection of shawls, scarves, and carpets of incomparable richness and beauty. Whole days may be spent in inspecting this division. It is a dangerous place for the rich, they may ruin themselves there. We should walk through it with the consciousness of an empty purse,

and then there would be freedom from temptation. This East is still the country of the Arabian Nights, the region of Aladdin and the Wonderful Lamp.

The English jewellery is very beautiful, although it cannot, I think, be properly said to be English, since it is principally the production of foreign workmen. The great superiority in this division of English manufacture, is found in the plate, and that description of ornaments which consists in silver vases and statuettes. These latter are, in England, peculiarly national. *Testimonials* are much in vogue here. They are given as racing and hunting cups, for speeches in parliament, the construction of a railway, or the building a bridge. They are family furniture, the ornaments of the sideboard and the table; they are a species of art and manufacture developed by the taste for horses, and the habit of horse exercise, hunting, and what is called *sport*.

It is in works of taste that France excels; and in this category may be classed the silks and lace. The Lyons manufacturers have made a collective exhibition; they have glass cases containing the choicest articles, and which are thus, of their kind, somewhat like the tribune of Florence, or the "salon carré" in the Louvre, a collection of *chefs-d'œuvre*. This comparison is induced by the magnificence of the design and of the colours; they are real pictures; and there are some silks in imitation of Chinese, which may be compared to beautiful landscapes.

But here are Sèvres and the Gobelins! Here we are incontestably masters. This division is a little kingdom, of which no nation can dispute with us the sovereignty! Crowds of foreigners congregate here to admire and purchase our productions, and almost everything here has been long since sold.

Russia has also a sumptuous display. It would be neces-

sary to build a palace expressly for the enormous doors and vast vases in malachite, which fill this division. They are a little heavy, but still truly magnificent. Prince Demidoff exhibits pieces of malachite and gold from his mines. But here are again some policemen on guard; there must be some jewels. In fact, Russia exhibits the most beautiful diamond ornaments, very delicately mounted, and a jewel case in black marble, with bunches of grapes in amethyst, and cherries in coral. In general there is, in this Russian division, a certain air of grandeur and rude luxury — riches, as it were, fresh wrested from nature, and torn from the bowels of the earth.

Let us give our eyes a little repose by going to see the stuffed animals in the compartment of the Zollverein; they are amongst the most amusing and "spirituel" objects of the Exhibition. There are a series of scenes in caricature imitation of life, in which small animals are introduced with the most ludicrous fidelity. There is a rabbit-hunt by weasels; a fox who seduces an innocent little cat; a party of little animals drinking tea; others who are seated at the piano and singing; and several other scenes, in which the perfect imitation prevents them from being caricatures.

I prefer this imitation of animals to that of man, such as may be seen in the English division under the form of a mannikin. This is an Apollo Belvedere in mechanism, for the use of tailors, that may be lengthened or shortened at pleasure. It seems that the anatomy of this movable doll is very curious, and contains about 7000 pieces. Whilst we are on the subject of tailors, I would direct your attention to the water-proof paletots, to which they have given the name of *piuma*, and which are so slight that they may be put in a small case, and carried in the pocket. I really think they might be enclosed in a cigar-case. As a contrast to

this, go and look at the immense sheet of paper exhibited in the English nave, and which is not less than 2500 yards long. When we imagine that this endless paper may, perhaps, be filled with the prosaic effusion of some dull writer, we begin to feel some scruples, and find it necessary to allay the apprehensions of our readers, and close this letter.

LETTER III.

A Frenchman may, I think, look at the Crystal Palace with pride. In this festival of nations, in this pacific and glorious competition of human industry, France stands pre-eminent in the products of art, taste, and imagination. To her, as to her daughters, is accorded, in all times and in every clime, the palm of grace and elegance. We are told that when the fairies, in the dispensation of beauty, distributed their gifts to the women of the various nations of the world, they gave to one regularity of feature, to another symmetry of form, to this the lustre of the eye or the luxuriant richness of the hair, to that the complexion of the lily and the rose, but that it happened that in this distribution the fair ones of France, or rather the "Parisienne," was overlooked. The other daughters of the earth, to repair the injustice of chance, and to afford consolation to their sister, deprived themselves for her sake of a part of their attributes, and each plucked from her crown or her girdle a flower, wherewith to form for the neglected fair a bouquet. Thus the "Parisienne," instead of one gift, participated in all, and of these varying fragments she formed that inimitable and indefinable whole which bears her name. Like to this it would seem is the character of the

products of France; the industry of France is now, as ever, that of art. Look at her silks, her carpets, her porcelain, her jewellery, they are the work of the veritable artist, and their taste is always superior to their material. It may aptly be said that France produces the flowers, and England bears the fruits of civilisation.

The department where England shines in all her splendour is that of machinery. It is indicated by its deep and heavy murmur, like the distant roar of the torrent. There the ebullition of the steam-boiler, the cataract of the centrifugal pump, the groan of the press, and the whirl of the spindle, combine in acknowledging the supremacy of science. Fire, air, water, steam, electricity, are all exerting their agency, and may, without much figure of speech, be said to be monsters of nature chained to the triumphal car of the human will, and venting their impotent rage in groans and imprecations. Beware how you approach them in their fury. Extend to them but a finger, they will seize the hand, and, powerless in their grasp, you will become a victim to your imprudence. When unenlightened by practical science, as I confess myself to be, we are perhaps more forcibly struck by the mysterious grandeur of this spectacle. Here thousands of threads, little sticks, and bits of steel, are engaged in incomprehensible warfare, and resemble so many demons under the influence of some occult power. A few delicate hands, the slight finger of a woman or a child, can regulate and direct these myriads of movements. Machinery gradually supplies the place of handicraft, and we may venture to foresee an epoch at which man will have no occupation, and may sit beside it, viewing its operations with folded arms. And one may say with the poet: " Thou art black but comely, O city of man! Thou hast a soul, the fatal and glorious creation of our hands. Thy thousand intelligent arms leave us to inac-

tion; and man is left with nought to do but to think, and inebriate himself with thinking till death."

There is in the Exhibition one thing which particularly attracted my attention, albeit though modestly placed in a retired position, — a small glass case containing copies of the Bible in all languages with this motto, "Multæ terricolis linguæ, cælestibus una." This collection of Bibles forcibly exhibits the ardent propagandism of the English, one of the grandest and finest aspects in which this nation can be viewed. With steam and the Bible, the English traverse the globe.

One of the great results of the Exhibition will be, that all nations will improve by means of mutual example and comparison. If the English give us lessons in industry, they may, on their part, learn from us to assign to art, properly speaking, a higher position. Taste is perfected in proportion as the level of equality ascends; inferior products are no longer in demand, superfluities have become necessaries, and the beautiful is as requisite as the good. I have always thought, that if the English are not real artists, the reason is to be found in their indisposition to lose their time. It is sometimes desirable to lose time. Works of imagination are the offspring of repose and leisure. The poetic spirit is naturally free and spontaneous, and will not endure coercion. There are some people who seek all means of killing time. The English, on the contrary, seek all means of saving it. It is sometimes fatiguing. You must be always on the alert; even the double knock of the postman, which warns you from the other end of the street not to keep him waiting, at last irritates you. This is a country in which it is impossible to be otherwise than punctual. And then everything in it is so well arranged, so well regulated. After observing that people walking in the same direction keep the same side of the footpath, — after observing the policeman, so well dressed,

and so perfectly buttoned, walking before houses which resemble each other exactly, one feels occasionally the imperious necessity of irregularity. One has an irrepressible desire to sneeze as in the middle of a sermon, or to walk on one's head a little, if it were only for a change. Decidedly they are a great people, but they are a little deficient in disorder, and they don't know the pleasure of musing.

Let us turn to America, it is there we shall find works of art! The Americans have invented, for instance, a piano which plays violin; 'tis original, and economical to boot — it saves one man's time; it is one artist the less in the republic, and Plato was opposed to having any. The anticipations of the Americans were more "grandiose" than their display. They complained that they had not had sufficient space assigned to them; a concession was made of as much as they desired, and it was comparatively empty. Thus to conceal the nakedness of their walls, they sent quantities of india-rubber. Amongst other articles, they exhibited gigantic boots in caoutchouc — really seven-league boots — fitting emblem of Jonathan, who, when he walks a step, necessarily makes the stride of a giant. They were seized with a mania, too, of exhibiting ladies' bonnets! 'Tis true, gentle reader; yes, actually, fashions from America! Now what the "fashions" of England are to the "modes" of France, the "just the thing" of America is to the fashions of England. Draw your own conclusions. Another curious article of American exhibition, is carriages. There is one so light, it may be moved with the finger; you may readily imagine it to be made of paper, and the wheels have not a breadth of a quarter of an inch. It reminds me of the bailiff of Ferrette, whose legs were so thin, that Talleyrand called him the most courageous man in the world for venturing to stand. What matters it? With this break-neck affair, which appears to be made not

even to skim the ground, or raise the dust, the American traverses space like an arrow. It is not idly he takes for device "Go ahead!" He is ever going, and he will go farther still. A model is exhibited in this division of the large steam-boats which descend the rivers of the New World, carrying whole houses in which you may hire apartments.

In order to arrive an hour before a rival, the American will get up his steam to the "top of all the atmospheres," and will courageously blow himself and his migratory city, with all its population, into eternity.

Oh, America! America! with thy "*far west*," — with thy prairies without limit,—with thy forests, compared with which ours are but as clusters of trees,—with thy rivers, near which ours would diminish to brooks, — with thy lakes, vast as our seas, — with thy cataracts and abysses — America! with thy growing industry, with thy indomitable spirit of enterprise, and the superb and insolent daring of thy children — oh! there is in thee, thou New World, in thy new race, and thine adolescence of nature, something which attracts as the sun, as the future and the mysterious! From the over-populated shores of the Old World what thousands of desires are directed to thee, thou land boundless and free! I picture thee to myself, America, opening thine arms to the hungry, the outcast, the hopeless, and the wretched of all nations, and exclaiming — Come ye! Come ye! I have space for ye, come ye! I have for ye land, and sea, and woods, and rivers! I have iron for ye, and lead! I have work, I have bread, I have air, and ye may breathe! I have gold, and ye may be enriched! Cast off your shoes and shake off the dust of the Old World, come and refresh yourselves in the living waters of nature! *Ad nos, ad salutarem undam, venite, populi!*

LETTERS OF M. HECTOR BERLIOZ.

LETTER I.

You will not, I hope, be under the apprehension of receiving from me a hundred thousandth description of the Crystal Palace and its wonders, an ode to English industry, or an elegy on French indolence, with sundry digressions, in which would be found, more or less literally reproduced, the observations of the host of people who crowd the colossal glass edifice, the murmurs of the fountains which pour their freshness around, and the solemn peal of the organ, concealed amidst the foliage of druidical trees, rising heavenward, as in one incessant prayer, and consecrating human industry. You know my opinion of *impertinent* music; you need not then fear that I add my impertinent prose to that with which so many pens, eloquent or frivolous, ignorant or "savantes," artistical or venal,—pens of gold, of silver, of iron, of goose-quill,—have inundated the two hemispheres on this subject.

No, no. I said "*Hug!*" like a Mohican, the first time I entered the edifice. I uttered an English exclamation that I need not repeat, on entering a second time; and I so far forgot myself as to suffer a French "sacrebleu!" to escape me on my third visit: but to define to you precisely these three celebrated exclamations, I will not venture;

besides, I should not succeed in the attempt—the "hug!" especially is indefinable.

I cannot even comment on the comparative merits of the exhibitors who contest the prize for the fabrication of musical instruments; the reserve imposed on the members of the jury, to whom is referred the consideration of their respective claims, would prevent me. We are only authorised to give a collective opinion, and mine, individually, is, moreover, not yet decidedly formed. One thing is certain, if we except the singers, a race diminishing daily, modern music cannot want organs to produce its conceptions with precision and to vary its expression to infinity. Unhappily, the abuse is so nearly allied to the use, there is so much ignorance, such gross *indiscretion* in the employment of these instruments by the majority of composers, that, in my judgment, it would be desirable to diminish rather than increase their number. From the monstrous chaos, the palpable absurdities we frequently find produced in dramatic (or at least theatric) music, by the abuse of which I speak, it might almost be desired that sumptuary laws as regards the art of music were introduced; and we can almost consider as rational the ludicrous severity of the Greek judge, who condemned a player on the lyre to banishment for adding an additional string to his inexpressive and puerile instrument. Thirty years more persistance of musicians in the road they are now taking, and of the great art we still possess, will leave nothing remaining but the rhythm and the unison, reduced to their most unscientific forms. It should also be considered, that the major part of the new instruments, which would be so beautiful and so valuable employed with intelligence aided by taste, have not yet found artists capable of rendering themselves masters of them, and surmounting the mechanical difficulties which they present. Sufficient time for studying

them has not been allowed. A man, whether he be or not a musician, has scarcely blown into a brass instrument six months, than he aspires to enter an orchestra, and turn his acquisition to profitable account. Violin, violoncello, hautbois, flute, clarionet players, and many others, work almost incessantly for years before putting forth the same pretensions; and yet any incorrectness in their playing is not more disagreeable in concerted music than that of these stentors, whose formidable sounds too often drown the melody of their harmonious brethren.

In the present state of music it would, I think, be better, while doing full justice to the inventors of really useful instruments, rather to induce them to render more perfect those which exist, as regards correctness, purity, and beauty of tone, than to encourage them to increase their power and multiply their number by varieties which have no distinguishing character of adequate importance.

A new and powerful direction should also be given to composers, to the leaders of orchestras, and the public, to bring them back into the paths of reason and art, from which they now deviate with such barbarous indifference. But this depends on an order of things which exists not now in Europe, and which, probably, it will not be our lot to witness. Europe has other evils to redress, other instructions to afford, other follies to remedy, other interests than those of art to protect.

England, if she could understand their importance, could alone give birth to those institutions in which we are deficient; for, thanks to the tranquillity she enjoys, she accords to the arts, and especially to music, a liberal patronage, and exhibits for it a lively and enlightened taste. Of this she gives, at this moment, a most striking proof. Although her manufacturers of musical instruments, with, perhaps, two

exceptions, have little reputation and importance, she has selected to appreciate their labours during the Exhibition four competent judges, chosen amongst the most eminent musicians of the United Kingdom,—Sir George Smart, Sir Henry Bishop, Mr. Sterndale Bennett, and Dr. Wylde. France has but one representative in this musical jury. The Zollverein and Austria have each also only one; the first of these states has deputed M. Schafnæuil, and the second M. Thalberg. As to Prussia, Sweden, Denmark, Belgium, Naples, and Spain, we have heard no mention of them, and no one has appeared to represent them in the laborious and difficult duty, of which, however, a great many instruments from Brussels, Berlin, and Copenhagen, have furnished the materials. Belgium, it is true, is accustomed to consider as pertaining to her everything French; Italy is losing her importance, and Spain has not yet acquired a knowledge of the art of music.

England, and this is a fact but little known on the Continent, has, within a few years, formed several associations of great importance, in which music is not an object of speculation as in the theatres, and in which it is cultivated extensively with care, talent, and a real love of art. Among these may be noticed the *Sacred Harmonic Society* and the *London Sacred Harmonic Society*, at London, and the *Philharmonic Society* of Manchester and Liverpool. The two London societies, which perform oratorios in the vast concert-room of Exeter Hall, consist of nearly six hundred choral singers. Their voices are not, it is true, the finest, although they appear to me much superior to Parisian voices properly speaking, but their "ensemble" produces an imposing and essentially musical effect; and, in fine, these choristers are capable of executing correctly the works, complex though they be, and whose intonations are sometimes so hazardous, of Handel

and Mendelssohn, — in other words, the most difficult choral music. The orchestra which accompanies them is insufficient only as regards numbers. In respect to the simple character of the instrumentation of oratorios in general, little is left to desire. It is by this well-organised mass of amateurs, assisted by a small number of professional persons, that I have heard the magnificent sacred poem of *Elijah*, the last work of Mendelssohn, executed.

Between this institution and those which have enabled our "ouvriers" of Paris to sing once a year in public some street songs, more or less miserable, there is, you perceive, an immense abyss. I have not yet had an opportunity of appreciating the musical society of Liverpool. That of Manchester, now under the direction of our friend, Charles Hallé, the model of pianists, the musician "sans peur et sans reproches," is, perhaps, superior to the societies of London, if we may rely on the opinion of impartial judges. The beauty of the voices is at least extremely remarkable, the sentiment of music very delicate, the orchestra numerous and well practised, and the ardour of the *dilettanti* so great, that four hundred supernumerary auditors pay each half a guinea for the right of purchasing tickets, in cases that, however, are rare, in which, by the absence or illness of any of the regular subscribers, it may be possible to procure them. Supported by so much zeal, however expensive it may be, a musical institution cannot but be prosperous.

Music has inexpressible charms for those who have taste for and appreciate it, while by those who make a commerce of it, it cannot be raised into much esteem. This is the cause of its being in our day so capricious, so presumptuous, and so absurd in the greater part of the large theatres of Europe, which are matters of speculation, in which we see it so atrociously undervalued.

Amongst the musical institutions of London, which are but little known on the Continent, I would mention two which are solely devoted to instrumental music. The Philharmonic Society, that rival of the "Société des Concerts" of the Conservatoire of Paris, is too celebrated to need any particular notice.

I will commence by the *Beethoven Quartet Society*. It will be obvious that these performances can require only four performers, their object being to execute, at stated and not distant intervals, the quartets of Beethoven. The programme of each evening contains three of these and nothing more. They are generally selected from the three different styles of the master, and it is always the last, that of the third epoch (the epoch of the pretended incomprehensible compositions of Beethoven), that excites the most enthusiasm. The English may here be seen following by reading from the score, on small cards printed for this purpose, the capricious flights of the imagination of the master, whence it might be assumed that many of them know at least how to read the score. I may, however, be permitted to entertain some doubts as to the skill of these devourers of harmony, from having observed, in looking over the shoulder of one of them, that he appeared to be reading from page 4, while the performers were at page 6! The amateur, doubtless, belonged to the school of that king of Spain, whose mania was to play the first violin in the quartets of Boccherini, and who being always a bar behind the other performers, was accustomed to say, when the "charivari" became too obvious, "Go on, I shall soon come up to you!"

This interesting society, founded, if I am not deceived, by Mr. Alsager, an English amateur, whose end was truly tragical, is now under the direction of M. Scipion Rousselot, our countryman, who has long been settled in England. A man

of the world and of intelligence, an able violoncellist, a learned and clever composer, an artist in the truest sense of the term, M. Rousselot was better qualified than many others to ensure the success of this enterprise. He selected three excellent virtuosos, all full of zeal and admiration, for these extraordinary works. The first violin is the German Ernst—Ernst himself—more winning, more passionate, more dramatic than ever. He has latterly improved considerably in fulness and beauty of tone, and precision of time. The second violin is entrusted to Mr. Cooper, an English violinist, whose playing is faultless and perfectly neat, even in the execution of the most complicated passages. He never endeavours, however, to render his performance conspicuous as do many of those who emulate him, and never gives to his part more importance than was intended by the author. The tenor is played by Mr. Hill, also an Englishman, the first tenor player perhaps in Europe, a real master, and having, besides, an incomparable instrument. The violoncello, in fine, is in the safe hands of M. Rousselot. These four virtuosos have already played a hundred times the whole of the quartets of Beethoven; but, spite of this, they never omit to practise carefully and minutely for three days before each public performance. It may readily then be conceived that the quartets of the Beethoven Society must be the most perfect that can be heard, and that they have attracted, and maintain to this moment, the most lively interest of English amateurs.

Another periodical concert of the same kind also is given at London, under the title of the "*Musical Union*." This, founded by Mr. Ella, a distinguished Scotch performer, a member of the fine orchestra of Covent Garden, has not for its exclusive object the propagation of the quartets of Beethoven, but that of all the great instrumental compositions for the "salon," to which are sometimes added one or

two pieces of vocal music, generally of the German school. Mr. Ella, although a violinist of talent himself, has the modesty to confine himself to the office of managing director of these concerts, without taking any part as a performer. He prefers associating with the most talented virtuosos of London those foreigners of celebrity who are occasionally passing through it; and it is thus that he has this year been enabled to unite with MM. Deloffre, Hill, Webb, and Piatti, the celebrated violinist Sivori, and the extraordinary contrebassist Bottessini. The public are well satisfied with a system which procures them, at the same time, excellence of execution, and a variety of style which could not be obtained in always having the same first violin. Mr. Ella does not confine his attention solely to the execution of the *chefs-d'œuvre* which form these concerts, but he is desirous that the auditor should relish and understand them. Consequently, the programme of each performance, sent in advance to the subscribers, contains a synoptical analysis of the trios, quartets, and quintets to be played, an analysis generally well written, and which speaks at once to the eye and the mind by joining to the critical text the notes of one or several movements, showing either the theme of each piece, or the most striking strains in it, or the harmonics, or the most important modulations which are found in it. Zeal and attention cannot be carried further. Mr. Ella has adopted as a motto of his programmes the French phrase, of which, unhappily, the reason and truth are little appreciated with us, and which he gathered in conversation with our "savant," Professor Baillot: "It is not enough that the artist should be well prepared for the public, but the public must also be prepared for what they are to hear."

Unhappy dramatic composers! if you have genius and feeling, imagine your auditors preparing to hear your works

by stuffing truffles and champagne, and coming to the opera to digest them! Poor Baillot was dreaming.

I heard this morning at the *Musical Union*, amongst other select works, the beautiful quartet in E minor, of Mendelssohn, and the trio for the piano in C minor, of Beethoven. How surpassingly wonderful are these trios! What torrents of ideas are comprised in them! After that in B flat, to which I know nothing of the same kind that is comparable, the trio in C minor is, I think, the most admirable; I could listen to it the live-long day. Ah! are my wishes to be gratified? Yes; they have recommenced. You must allow me to interrupt my letter to listen to it.

I should tell you that I have an apartment in the very house in which are the "*Beethoven Rooms.*" These concert-rooms, capable of holding about two hundred and fifty, are frequently let for a smaller auditory. Now, when music is performed in them, the door of my apartment on the staircase which leads to them, enables me to hear all that is played. There is a concert this evening, and they have begun the trio in C minor. Let me open my door as wide as possible. Welcome, a thousand times welcome, sublime melody! How magnificent!—how beautiful! Whence could Beethoven have drawn the inspiration that produced these multitudinous passages, each more poetic than the other, all differing, all original, and without having that type of conception which characterises even the great masters most celebrated for their fecundity? What ingenious developments! What unanticipated movements! How he spreads his wings and takes flight, this untiring eagle! How he hovers in his heaven of harmony! He darts downwards — he is lost — he again attempts the skies — he descends to the depths of darkness—he disappears—and now again you find him high, high in æther, his eye more fiery, and with wing of greater

power, impatient of repose, chafing, athirst for eternity! Well executed! — admirable! Who is at the piano, John? 'Tis an English lady, Sir. An English lady! Genius itself! But what now do I hear? A grand air of a prima-donna? Shut the door John! — quick — quick! Ah! still I hear her. Malheureuse! Shut the second door! — the third! — isn't there a fourth? . . . . At last I breathe again.

The singer from the concert-room has shattered my musical nerves by an emission of tones which reminded me of one of my neighbours of the Rue d'Aumale at Paris, who having the unfortunate mania that she was born to be a "diva," laboured and practised to fit her for her vocation from morning to night, and she has, by the way, a tolerably powerful voice. One fine morning, a milkman passing under her "persiennes," on his way to market, heard her shrill notes, and sighing, perchance from having left a Xantippe at home, exclaimed, "Ah! marriage isn't quite a bed of roses!" About the middle of the day, the luckless milkman passing the same place on his return, again heard the formidable, and, it must be confessed, not very melodious "*do, re, mi*" of the indefatigable "cantatrice." "Ah!" cried he, crossing himself; "poor woman! I was wrong; she is in labour, and has had a long and bad time of it!"

"A propos de cantatrice," I have at length satisfied the wish I had to hear the famous Chinese, "the small-footed lady," as the English advertisements and bills term her. The interest in hearing her consisted, so far as regarded me, in the question relative to the division of the gamut and the "tonalité" of the Chinese. I wished to know if, as many persons had said and written, they differ from ours. Now, after all the investigation I have made, and it is tolerably conclusive, I should say they do not. I will give you some idea of what I saw and heard. The Chinese family, com-

posed of two men, two women, and two children, were seated motionless on a little stage in the "salon" of the Chinese house at Albert Gate. The entertainment opens with a song of ten or twelve verses, sung by the *music-master*, with an accompaniment of a small instrument, with four metal strings, something like our guitars, played with a small piece of leather or wood, replacing the quills used in Europe to produce sound in the mandoline. The finger-board of the instrument is divided into compartments, marked by small linear projections, nearer together as they approach the sounding-board, exactly like our guitars. One of the highest projections, by the unskilfulness of the maker, has been inaccurately placed, and produces a tone somewhat too sharp, exactly like our guitars when ill made. This division produces results in exact conformity with those of our gamut. As to the union of voice and accompaniment, it is of such kind that it must be concluded that, at all events, this Chinese has not the slightest idea of harmony. The air (grotesque and abominable in every point) finishes on the key note, as the most common of our ballads, and is not modulated, that is (for this term is generally misunderstood by persons ignorant of music), does not vary from the "tonalité," or mode adopted from the commencement. The accompaniment consists in a rhythmical arrangement, lively enough, but always the same, played on the mandoline, and which accords but little or not at all with the notes of the voice. The most atrocious part of the affair is, that the young woman (the small-footed lady), to increase the charm of this strange concert, and without paying the least attention in the world to the production of her "savant" master, incessantly scratches with her nails the strings of another somewhat similar instrument, but with a longer finger-board, without playing anything having either melody or harmony. She

resembles a child, who, happening to be in a room when a piece of music is being played, amuses itself in strumming on the keys of a piano. It is, in fact, a song accompanied by a little instrumental "charivari." As to the voice of the singer, nothing so singular ever reached my ear; its notes were nasal, guttural, groaning, hideous, such as I may compare, without much exaggeration, to the sounds uttered by a dog, when, after sleeping a long time, he yawns while stretching himself. Nevertheless, the burlesque melody was perceptible enough, and I will one of these days note it down on paper, ruled after the Chinese fashion, as an addition to your album. This was the first part of the concert.

In the second the characters were inverted, the young woman sang, and her master accompanied her on the flute. In this case the accompaniment did not produce any discordance, the flute simply followed the voice in unison. This flute, somewhat similar to ours, differs only by its greater length, by its upper end, which is open, and by the *embouchure*, which is about the middle of the tube, instead of being, as in ours, near the top of the instrument. The tone is sweet enough, tolerably just, that is, passably false; and the player performed nothing which differed from the tonic system and gamut which we use. The young woman is endowed with a heavenly voice, as compared with that of her master. It is a mezzo-soprano, nearly similar in the "timbre" to the contralto of a young boy approaching adolescence, and whose voice is being matured. She sings pretty well, always speaking comparatively. One may imagine one hears a provincial cook-maid singing "Pierre, mon ami Pierre," whilst washing her dishes. Her melody, whose "tonalité" is very decided I repeat, and contains neither fourths nor eighths of a tone, but the most simple of our diatonic successions, is a little less extravagant than the "romance" of the music-

master. It is, however, so "tricornu," of a rhythm so difficult to catch by its singularity, that it will no doubt occasion me much difficulty to reduce it to writing for the purpose of presentation to you. But I will not be discouraged, and with the assistance I may derive from the lessons of the dog of my neighbour the baker, I will treat you to a Chinese concert of the first order. It must, however, be understood, that I do not regard this exhibition as an example of the real state of the art of singing in the Celestial Empire, spite of the "quality" of the young woman, quality of the highest order, if we may credit the director of the troop, the orator on this occasion, who spoke tolerably good English. The ladies of quality of Canton or Pekin, who content themselves to sing at home, and do not come to us to be exhibited in public for a shilling, must, I should imagine, be almost as superior to this lady as the Comtesse de Rossi is superior to the Esmeraldas of our *cafés*. The more so, since the young lady is not quite so "small-footed" as they would have us believe, and that her foot, the distinctive mark of women of the higher classes, may very well be a very good-sized plebeian foot, judging by the care she takes to allow only its point to be visible.

But I incline strongly to consider this proof as decisive of the question of the division of the gamut, and the *sentiment de la tonalité* in the East. I will believe only when I shall have heard it, that human beings can, on a gamut divided by quarters of a tone, produce something else than groans, fitted only for the nocturnal concerts of amorous cats. The Arabs have succeeded in this, as some *savans* affirm they have for this indescribable art a complete theory. I venture to assert that the *savans* who have written these fine things, know nothing of our music, or at least that they have only a confused and indistinct acquaintance with it. That the Arabs

may have a theory is very possible, but this can mitigate but little the horror they occasion in putting it in practice.

The music of the East Indians must differ very little from that of the Chinese, if we may judge by the instruments sent by India to the Exhibition. This collection consists :—1. Of mandolines of four or five strings, some with only one; their finger-board is divided by ridges, as those of the Chinese; some are of small dimensions, others of immense length; 2. Of a multitude of large and small drums, of the form of small casks, the sound of which somewhat resembles that produced by tapping on the top of a hat; 3. Of a wind instrument, with a double reed of the kind of our hautbois; 4. Of cross flutes, exactly similar to that of the Chinese musician; 5. Of an enormous trumpet, coarsely made on a model which differs little from European trumpets; 6. Of several small instruments played with a bow, the acute and feeble tone of which remind one of the little deal violins made as playthings for children; 7. Of a kind of tympanum, the strings of which, stretched over a long box, appear to be struck with sticks; 8. Of a small harp of ten or twelve strings, somewhat like the Theban harps, of which we learn the form from the Egyptian bas-reliefs; and, in fine, Of a large wheel filled with gongs or tamtams of small dimensions, the noise of which, when put in motion, must have somewhat the same charm as the large bells attached to the head and neck of carriers' horses. I conclude, in fine, that the Chinese and Indians would have a music similar to ours, *if they had any;* but that in this respect they are still plunged in the most profound darkness of barbarism, or in an infantine ignorance, hardly exhibiting some crude and powerless instincts.

LETTER II.

I INTEND to write you as to the lyrical theatres on some future occasion, but I am now under the influence of so strong an impression, that I must first be permitted to inform you of its cause.

On Thursday last, the annual meeting of the charity school children of London was held in St. Paul's cathedral. Remembering to have read an account of this ceremony given some years since, I expected no ordinary spectacle, but the reality has infinitely surpassed all that imagination had conjured up.

It is the most extraordinary thing I have ever seen or heard. You know that it is not my habit lightly to employ the language of admiration.

A scrap of a newspaper which accidentally came to my hands last week, informed me that the *Anniversary Meeting of the Charity Children* was about to take place. I immediately set out in quest of a ticket, which, after application to many persons and considerable trouble, I succeeded, by the kindness of Mr. Goss, the principal organist of St. Paul's, in obtaining.

From ten o'clock in the morning, an immense crowd filled all the avenues to the church, through which I succeeded, not without difficulty, in making my way. When I arrived in the organ gallery, in which were the singers of the cathedral, male and female, numbering about seventy, I was requested to sing a bass part with them, and was asked to put on a surplice, that my black coat might not destroy the harmony of the general white costume. Thus disguised, I waited with an indescribable emotion, caused by what I witnessed, for that which I was about to hear. Nine

amphitheatres, almost vertical, each containing sixteen seats, raised one above the other, were erected for the children, in the centre of the building under the cupola, and in front of the organ. The six erections beneath the cupola, formed a sort of hexagonal circle, having openings only at the east and west. From this latter opening proceeded an inclined plane, terminating above the principal entrance, and already occupied by an immense mass of persons, who could thus, even from the most distant seats, see and hear everything distinctly. To the left of the gallery in which we were placed, and before the organ, was a temporary erection for seven or eight persons, who played trumpets and kettle-drums. On this a large looking-glass was placed, so as to show in it, by reflection, the motions of the director of the choir in beating time, in an angle below the cupola, and commanding the whole of the choral corps. This looking-glass also served to guide the organist, whose back was turned to the choir. Banners placed in different parts of the vast amphitheatre, the last seat of which was about level with the capitals of the columns, indicated the place appropriated to each school, bearing the name of the parish, or part of London, to which it belonged. These several compartments, filled successively from top to bottom with children, presented a curious *coup d'œil*, resembling somewhat the effect produced by the microscopic phenomena of crystallization.

The points of these crystals, formed of human molecules, directing themselves continually from the circumference to the centre, were of two colours, the dark blue of the coats of the little boys on the higher seats, and the white frocks and caps of the little girls on the lower seats. Besides this, the boys wearing on their waistcoats, some a brass plate, others a silver medal, produced by their motions a continued scin-

tillation by the reflection of the sun on the metal, alternately lighting up and being extinguished at every moment on the dark background of the picture. The aspect of the high scaffolding occupied by the girls, was still more curious. The green and red ribbons, which adorned the heads and necks of these pretty children, made this part of the amphitheatre exactly resemble a mountain covered with snow, amid which peeped out here and there blades of grass and flowers. Imagine, in addition to these, the various shades of colour exhibited in the chiaro-oscuro of the inclined plane on which the public were placed, the throne of the Archbishop of Canterbury covered with red, the richly decorated seats of the Lord Mayor and the English aristocracy in the space below the cupola, and above these the gilded pipes of the organ; imagine the magnificent church of St. Paul, the largest in the world after St. Peter's, forming, as it were, a frame to the whole picture, and you will then have but a very imperfect idea of this incomparable spectacle. And everywhere prevailed order or devotional silence, a calm which redoubled its magic. No theatre, however magnificent and splendid, — no decorations, — no "mise en scène," even though they were the creations of imagination far surpassing any possible result of art, could ever vie with this reality, which even now I can only believe to have been a vision of the night. As the children, in their new clothes, took their seats with a subdued joy, in which was no symptom of disorder, but which was obviously accompanied with some little pride, I heard my English neighbours say, "What a splendid spectacle! What a glorious sight!" — and my own emotion was overpowering when *six thousand five hundred voices* burst forth in stupendous unison with —

> "All people that on earth do dwell,
> Sing to the Lord with cheerful voice!"

the commencement of the first verse of the psalm, accompanied by the solemn peals of the organ. It would be vain to attempt to convey an idea of this sublime and unparalleled musical effect. It was, as compared with the power and beauty of the finest vocal masses ever heard, as St. Paul's of London is to the little church of Ville d'Avray,—nay, a thousand times more stupendous. This chorus of long and sustained notes, and of superhuman character, was supported by superb harmonies from the organ, which mingled with it its most powerful tones, but without being able to drown them. I have been agreeably surprised to learn that the music of this psalm, so long attributed to Luther, is by Claude Goudimel, "maître de chapelle" at Lyons in the sixteenth century. It was printed, for the first time, at Geneva, in 1543, and very probably with Latin words.

Spite of the hysterical nervousness I experienced, I sufficiently controlled myself to take a part in the prose psalms that the choir of professional singers had in the next place to perform. The Te Deum of Boyce (written in 1756), a composition without any particular character, sung by the same persons, sufficed to calm me. In the Coronation Anthem, the children joining in the chorus of "God save the King! Long live the King! May the King live for ever! Amen. Hallelujah!" the electrification began anew. I paused, notwithstanding the assiduous care of one of my neighbours, who pointed out to me the place in his copy, thinking I had lost it. But at the psalm, in triple time, of an ancient English composer (1774), sung by all the voices, with accompaniment of the organ, trumpets, and kettle-drums, and its re-echoes of thunder, a hymn deeply fervent of inspiration, of sublime harmony, and of expression as noble as impressive, nature reasserted her right, and, in my

weakness, if you so please to term it, I made use of my copy as did Agamemnon of his toga, and hid my face.

After this sublime "morceau," and while the Lord Archbishop of Canterbury was preaching, but whom I was prevented from hearing by the distance, one of the stewards came for me, and conducted me, still weeping, to different parts of the church, for the purpose of contemplating, under various aspects, this grand "tableau," the magnificence of which the eye could not comprehend from any single point. He afterwards left me below, near the pulpit, amidst the fashionable auditors, or, more properly speaking, in the abyss of the crater of this vocal volcano; and when, at the last psalm, it recommenced its eruptions, I found that, for persons so placed, its power was twice as forcible as in my former position. On going out I met old Cramer, who, in his transport of enthusiasm, forgetting that I was a Frenchman and that he spoke French, exclaimed, "Cosa stupenda! stupenda! la gloria dell' Inghilterra!"

And then Duprez . . . . the great artist, who, during his brilliant career, has ministered to the gratification of such hosts of persons of taste and feeling, received, on that day, payment of his long-deferred debt of gratitude; but that debt was paid not by France, but by the children of England. I never saw Duprez so excited. He stammered, he wept, he walked hurriedly to and fro, whilst the Turkish Ambassador and a handsome young Indian passed him enwrapped in impassibility, and with look sorrowful, as if they had heard their spinning dervises howling in a mosque. Oh, sons of the East! you are deficient in all moral sensibility! Will you never acquire it? . . . .

But I must descend from the regions of feeling and imagination to give you some more technical details. This institution of *Charity Children* was founded by George III. in

1764. It is supported by voluntary donations and subscriptions, which are made by the affluent. The sums received by the sale of tickets, from half-a-crown to half-a-guinea, also go in aid of its funds. Although all the places reserved for the public are engaged a long time in advance, the space occupied by the children, and the sacrifice necessarily made of a great part of the church to afford the accommodation for them, of which I have spoken, diminish considerably the pecuniary result. The expenses are also very considerable. Thus the erection of the nine amphitheatres above, and of the inclined plane, amount to 450*l.* sterling. The receipts of Thursday amounted to 800*l.* sterling, leaving only 350*l.* sterling, at most, to the 6500 poor little creatures who have given such an inexpressible treat to the mother city, although it is said that the voluntary subscriptions are very considerable.

These children know nothing of music, they have never seen a note in their lives. They are taught by playing to them on the violin, for three whole months, the hymns and anthems which they have to sing at the anniversary. They are thus taught by ear, and, consequently, do not bring with them either a book, or anything else, to guide them in their performance. This is the reason they sing only in unison. Their voices are fine, but want compass; and pieces are generally selected for them included within eleven notes, from B in the bass, to E between the two upper lines of the stave (key of G). All these notes, which are nearly common to the soprano, mezzo-soprano, and contralto, and are, consequently, of easy execution for every one, have wonderful sonorousness. It is doubtful if they could be sung in parts. Spite of the extreme simplicity and the liberty allowed in the melodies embraced by them, there is not, to the ear of the musician, a faultless *simultaneity* in the first utterance

of the note after a pause. This happens from these children being ignorant of time, and being unable to count. Besides this, their leader, placed high above the choir, can be seen distinctly by the upper ranks only of the three amphitheatres in front of him, and is, therefore, useful only in indicating the commencement of the passages, the greater part of the singers not being able to see him, and the others seldom deigning to notice him.

The extraordinary result of this unison is due, in my opinion, to two causes: first, to the enormous quantity and to the quality of the voices; and, next, to the arrangement of the singers in very elevated amphitheatres. The reflectors and the producers of sound being in good relative proportions, the air of the church, struck on so many points at once on the surface and in the recesses, vibrates simultaneously, and its echo acquires a dominion over, and a power of acting on, the human organisation, that the most scientific efforts of musical art, in ordinary conditions, have never yet produced. I would add, but conjecturally only, that, in an exceptional case such as this, many indescribable phenomena may take place connected with the mysterious laws of electricity.

I think it worth investigation, whether the cause of the marked difference which exists between the children brought up in the charity schools of London and those of our poor children in Paris, may not, in some measure, be due to their food — abundant and good as it is in the former, and insufficient and of bad quality as it is with the latter. This is very probable. These English children are strong, of well-developed muscle, and exhibit nothing of the miserable and sickly aspect presented by the population of the young operatives of Paris, enfeebled by bad diet, labour, and privations. It is very natural, moreover, that the vocal organs participate in these with the weakly state of other parts of the organisa-

tion, and that even the mind may partake of the same disadvantages.

However this may be, it is not only the voices which are wanting to produce at Paris, in so astonishing a manner, the sublimity of sacred music. What is first required, is the cathedral of gigantic proportions (even Notre-Dame would be insufficient); then, alas! an inspiration of art, a steady and fervent cultivation of it, patience, perseverance, subordination of pupils to their masters, a steady determination, if not of the Government, at least of the affluent, to attain the end, after having understood its importance; it is, in fine, the want of pecuniary means. We have only to remember, comparing small things with great, the melancholy end of Choron, who, with very limited means, having obtained important results in his school of choral music, died of chagrin from its suppression. And yet, by means of three or four establishments, which it would not be difficult to found with us, what should prevent our giving at Paris, in a certain number of years, an example on a smaller scale, but improved, of the English musical fête. We have not the church of St. Paul it is true, but we have the Pantheon, which offers, if not the dimensions, at least internal arrangements nearly similar. The number of performers and of auditors would be less colossal, but the edifice being also less vast, the effect might be still very extraordinary.

Suppose that the inclined plane from the top of the central entrance of the Pantheon would only contain five thousand auditors, still such an assemblage would be considerable, and would, I think, represent that portion of the population of Paris which possesses the intelligence and sentiment of the art. Suppose, now, that in the amphitheatres, instead of 6500 uneducated children, we had 1500 children musicians,—such, for instance, as little Beaumont,

who sings in the chorus of the Paris opera, — 500 female vocalists with good voices, and about 2000 men sufficiently endowed by nature and education. Again, suppose that instead of giving to the public the central lower part of the hexagon under the cupola, a small orchestra of 300 or 400 instruments were placed there, and that to this mass of 4300 musicians, well practised, were confided the execution of some fine work, written in a style adapted to such means, on a subject the grandeur of which should be equal to its magnificence, in which should be found the musical expression of all the elevated sentiments which can exist in the heart of man — think you that such a manifestation of the most powerful of our arts, aided by the "prestige" of poetry and architecture, would not really be worthy such a nation as ours, and would not leave far behind it the so much vaunted fêtes of antiquity?

With the sole resources of France, in ten years this fête would be possible. Paris needs but to will it. Meanwhile, and by the aid of the first rudiments of music, the English will demonstrate the will and the power. Great people, instinctive of great deeds,— the soul of Shakspeare lives in thee!

On leaving St. Paul's, in a state of semi-stupefaction, as you may readily conceive, I took boat on the Thames; and, after almost unconsciously having been drenched to the skin in a transit of some twenty minutes, I landed, half-drowned, at Chelsea, where I had nothing to do, and I had the right to expect to sleep: but the night succeeding such a day is not destined to sleep. I heard incessantly re-echoed in my ear that harmonious swell, "All people that on earth do dwell," and I saw whirling before my eye the cathedral of St. Paul. I was in its interior; it was by visionary trans-

formation changed to Pandemonium. I had before me the celebrated picture of Martin: instead of the Archbishop in his pulpit, I saw Satan on his throne; in lieu of thousands of the faithful and children grouped around him, it was peopled with demons and the damned, who darted from the depths of visible darkness their looks of fire; and the amphitheatre of iron, on which these millions were seated, vibrated in a frightful manner, giving out harrowing and discordant sounds.

At length, weary of the continuance of these hallucinations, I leapt from my bed, though scarcely light, went out, and wandered to the Exhibition, where, a few hours later, I had to attend as one of the Jury. London was still slumbering; neither Sarah, nor Mary, nor Kate, were yet to be seen, mop in hand, washing the doorways. An old Irish crone, somewhat "aginée,"* smoked her pipe, crouched under the entrance to one of the houses in Manchester Square.

The listless cows were ruminating, stretched on the turf in Hyde Park. The little ship, this plaything of a maritime people, lay at anchor on the Serpentine; already some luminous "gerbes" detached themselves from the elevated panes of glass of the palace open to "all people that on earth do dwell."

The guard who kept the door of this Louvre, accustomed to see me at all kinds of unreasonable hours, allowed me to pass, and I entered. It is certainly a spectacle of singular grandeur, the Palace of the Exhibition at seven in the morning; the vast solitude, the silence, the softened light, the *jets d'eau* motionless, the organs mute, the trees, and the surprising show of rich products brought from all nations of

* A word cleverly coined by the writer; *Anglicé*, "under the influence of gin."

the earth by hundreds of rival peoples, ingenious works, the sons of peace, instruments of destruction which remind one of war,—all these causes of motion and noise seemed at such time to be conversing mysteriously among themselves, in the absence of man, in some unknown language, understood by "l'oreille de l'esprit." I felt disposed to listen to their secret dialogue, believing myself alone in the palace; but there were three of us, a Chinese, a sparrow, and I. The eyes "bridés" of the Asiatic were open before their time, as it would appear; or, perhaps, like mine, had been but imperfectly closed. With a little feather brush he was dusting his beautiful porcelain vases, his hideous grotesque figures, his varnished goods, and his silks. He then took, in a watering-pot, some water from the fountain, and watered tenderly a poor Chinese flower, emaciated, doubtless, from being in an ignoble European vase; after which he went to sit down a few paces from his stall, looked at the tamtams hung there, made a movement as if to strike them, but, remembering that he had neither relations nor friends to awaken, he let his hand in which he held the gong-stick drop, and sighed. "Dulces reminiscitur Argos," said I. Assuming, then, my most winning manner, I approached him, and, supposing that he understood English, I addressed him with, "Good morning, Sir." The only notice I received was his rising and turning his back on me; he then went to a cupboard, took out some sandwiches which he began to eat without even honouring me with a look, and with an air of some disgust for this food of "barbarians." Then he sighed again. He was, no doubt, thinking of those savoury dishes of shark-fins fried in castor oil, in which he delighted in his own country, of the soup of swallow-nests, and of that famous jelly of caterpillars which they make so

exquisitely at Canton. Bah! the cogitations of this rude "gastronome" disgusted me, and I went away.

Passing near the large piece of ordnance, the forty-eight, cast in copper in Seville, and which always seems, being placed opposite the stall of Sax, to defy him to make a gun of its calibre, I perceived a sparrow hidden in the mouth of the brutal Spaniard. Poor creature! escaped from the massacre of the Innocents; do not be alarmed, I will not denounce thee. On the contrary—here—and drawing from my pocket a bit of biscuit that the steward at St. Paul's had obliged me to accept the evening previous, I crumbled it on the floor.

When the Palace of the Exhibition was built, a tribe of sparrows had taken up their domicile in one of the great trees which now ornament the transept. They determined to remain there, notwithstanding the menacing progress of the work of the operatives. The poor birds could not imagine that they would have been inclosed in a large glass and iron cage. When they found how matters stood, no doubt they were a little astonished. They sought an exit right and left. Fearing that they would injure the articles exhibited, it was decided to kill them all, and this was effected with cross-bows, nets, and the perfidious nux-vomica. My sparrow, whose hiding-place I now know, and whom I will not betray, is the sole survivor. He is the Joas of his people, and I will save him from the rage of Athalia.

As I pronounced these words, a noise resembling heavy rain was heard in the vast galleries; it was the *jets d'eau* and fountains which were set playing. The crystal "châteaux," the artificial rocks, vibrated under the fall of their liquid pearls,—the policemen, these "bons gens d'armes" unarmed, which every one respects with so much reason,

assumed their posts,—the young apprentice of M. Ducroquet took his seat at the organ of his master, thinking of the new polka with which he would treat us,—the ingenious manufacturers of Lyons were finishing their admirable display,—the diamonds, prudently hidden during the night, re-appeared sparkling in their cases,—the great Irish clock, in D flat minor, which surmounts the eastern gallery, struck one, two, three, four, five, six, seven, eight, proud of giving the lie to its sister of the church in Albany Street, which strikes in a major key.

Silence had kept me waking, these noises made me drowsy, the want of sleep became irresistible. I sat down before the grand piano of Erard, that wonder of the Exhibition. I leaned on its rich cover, and was about to take a nap, when Thalberg, tapping me on the shoulder, exclaiming, "Holloa! *confrère!* the Jury is assembled. Come, wake! we have to-day thirty-two musical boxes, twenty-four accordions, and thirteen 'bombardons,' to inspect!"

LETTER III.

The number of concerts is far from diminishing, they are given everywhere — at Hanover Square, Willis's Rooms, the Queen's Theatre, Exeter Hall, without reckoning those of the "unrivalled band" of Jullien at the Surrey Gardens, those of Vauxhall under the direction of the most rare virtuoso amongst the players of brass instruments that Paris has allowed herself to be deprived of.

I am convinced there is not a city in the world in which music is so much in vogue as in London. It pursues you even into the streets and that is not always the worst, many

artists of talent having discovered that the profession of itinerant musician is incomparably less irksome and more lucrative than that of a musician in an orchestra, wherever it may be. The service of the street lasts only three or four hours a-day, that of the theatres requires eight or nine. In the street they are in the open air, they can breathe freely, there is variety and change of place, and they have only to play from time to time some short piece. In the theatre there is to be borne, the heat of the weather, the heat of the public, the heat of the gas, to be always seated and always playing, sometimes even between the acts. At the theatre, moreover, a musician of the second order has only 6*l.* per month. This same musician, by attending public places, is almost certain of receiving in four weeks double, and often more than double. It is thus that one may hear with real pleasure in the streets of London, little groups of good English musicians, white like you and me, but who have thought fit to attract attention by colouring their faces.

These mock Abyssinians accompany themselves with a violin, a guitar, a tamborine, a pair of kettle-drums, and castanets. They sing quintets with agreeable harmony, and a rhythm and a melody sometimes original. They have, besides, an enthusiasm and animation, which show that their calling is not distasteful, and that they are contented. And then the shillings and even half-crowns come falling down like hail after each of their pieces, for they have time to learn them, know them well, and are never at fault. After these itinerant troops of real musicians, one hears with pleasure, too, a fine stalwart Scotchman, clad in Highland costume, and who, accompanied by two children wearing like him the plaid and the kilt, plays on the bagpipes the favourite air of the clan of the Macgregor. He is also animated, and becomes inspired by the sounds of his rural instrument, and the more the bag-

pipes wheeze, groan, squeak and squall, the more rapid, proud, and menacing become his gestures, and those of his children. You would almost imagine that these three Highlanders would, unaided, conquer all England.

You may now see passing, sad and sorrowful, two poor Indians from Calcutta, with their turbans and robes once white. Their only orchestra is composed of two small drums, in the form of casks, such as are seen by scores in the Exhibition. They are suspended about their body by a string, and are played by striking them with the extended fingers of the open hand on either side. The feeble sound emitted is reduced to a measure somewhat singular, and by its continuity resembles that of the rapid tic-tac of a mill. One of them sings with this accompaniment, in some Indian dialect, a pretty little melody in E minor, comprising only six notes, from E to C, and so sorrowful in spite of its quick time, so suffering, speaking so powerfully of the exile or the slave, discouraged and deprived of his eastern sun, that in listening one feels an attack of nostalgia.

In another place you have the Chinese sailors, who now give on board the junk "soirées musicales et dansantes." Here, after the first sensation of disgust which you cannot avoid feeling, hilarity reigns absolute, and laugh you must, laugh till you split your sides, laugh till you can't see. I have seen some English ladies finish by falling in a fainting fit on the deck of the celestial ship, such is the irresistible power of this oriental art. The orchestra is composed of a great tamtam, a pair of cymbals, a kind of wooden hat, a great wooden bowl supported on three legs and played with two sticks, a wind instrument not unlike a cocoa-nut, which being breathed into produces the sound Hoo! Hoo! or a sort of howl, and lastly a Chinese violin. But what a violin! (There are some like it at the Exhibition.) It is a tube of

great bamboo, very thin, and about a foot and a half long, which may be compared to a hollow hammer, the handle of which is fixed near the top of the head, instead of being in the middle of the mass. Two fine silken strings are stretched, no matter how, from the upper end of the handle to the top of the head. Between these two strings, lightly twisted one on the other, passes the hair of a romantic bow, which is thus forced, when pushed or drawn, to cause both strings to vibrate at once. These two strings are discordant, and the sounds which result are frightful; nevertheless, the Chinese Paganini, with a solemnity worthy the applause he obtains, holding the instrument resting on his knee, employs the fingers of his left hand on the upper part of the double strings to vary their intonation in the same manner as a violoncello player, but without observing any relative distances for tones, semi-tones, or any interval whatever. He thus produces a continuous series of scraping noises and feeble mewings, which give one the idea of the cries of a newly born infant, a ghoul, or a vampire!

In the "tutti," the "charivari" of tamtams, cymbals, violins, and cocoa-nuts is more or less furious, as he of the wooden bowls (who, by the way, would make an excellent kettle-drummer) increases or retards the roll of his drum-sticks on his wooden hat. Sometimes, indeed, on a sign by this virtuoso, filling at the same time the offices of leader, kettle-drummer, and singer, the orchestra makes a sudden stop, and after a short pause strikes fortissimo a single note. The violin alone is always squeaking. The vocal part is taken up successively by the leader and one of his musicians in the form of dialogue. These two men, employing the falsetto intermixed with tones produced from the chest, or rather the stomach, appear to be reciting some celebrated legend of their country. Perhaps they are chaunting a hymn

to their god Buddah, whose effigy with his fourteen arms adorns the interior of the chief cabin of their ship.

I will not attempt to depict the cries of a jackal, the death rattle, the turkey-cacklings, amidst which, notwithstanding my utmost attention, it was not possible to discover more than four appreciable notes (re, mi, si, sol); I will only say, that the superiority of the small-footed lady and her music-master were conspicuous. Evidently the performers of the Chinese family are artists, and they of the junk only sorry amateurs. The dancing of these singular beings is on a par with their music. Such hideous contortions I never beheld. You might imagine a troop of devils were before you, twisting, grimacing, jumping, to the hissing of all the reptiles, the howling of all the monsters, the "fracas" of all the tridents and boilers of the infernal regions. It would be difficult to convince me that the Chinese are not all mad. However that may be, I will say no more of them, they have I think already occupied too large a space in my correspondence; but I do sincerely hope that no one of common sense will have any more faith in their music.

INDEX.

THE END.

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ERRATA.

Page 193, line 10 from bottom, for "dynanometer" read "dyna*m*ometer."
Page 262, line 2 from bottom, for "27·10" read "2·71."

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